Testing, Adjusting, Balancing, & Start-Up

Automatic Controls Acceptance Testing

&

Duct Air & Leakage Test

A Reference Handbook

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NAVFAC ATLANTIC
Construction Engineering Branch, Code CI52

April 2004

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PREFACE

Over the past two decades, there has been a continuing trend towards more sophisticated and complex Heating, Ventilating, and Air Conditioning (HVAC) Systems for all facets of new building construction. This trend has been fairly universal in that it has evolved both within Government and the private sector. Commercial, institutional, and industrial facilities have all seen change.

There is no single reason as to why this trend has occurred. Instead, it would appear to be fueled from several directions. Recognition of the need to increase levels of energy conservation, increased awareness of the importance of proper indoor air quality, the increasing sophistication of operational demands (such as temperature and humidity control requirements) within new facilities, and increased expectations (such as multi-zone control) by facilities' users have played a contributing role.

To meet the increased demands of testing and verifying proper installation and operation of these new systems, there is a recognized need within the HVAC industry to provide a structured and organized systems approach for this effort. For this purpose, the Atlantic Division, Naval Facilities Engineering Command (NAVFAC ATLANTIC/PACIFIC) has implemented the Testing, Adjusting, Balancing, and Start-up (TABS)/Automatic Controls Acceptance Tests (ACATS)/Duct Air Leakage Tests (DALTS) Program, which is patterned after industry-accepted practices.

This handbook is intended to provide an informational reference guide to OICC/ROICC personnel on the TABS/ACATS/DALTS Program. The contents are for guidance and information use only and should not be considered to be a directive.

TABS/ACATS/DALTS: AN INTRODUCTION

WHAT IS THE TABS/ACATS/DALTS PROGRAM?

TABS/ACATS/DALTS is a process, which uses a combination of submittals and work activities to provide an efficient, thorough means of identifying deficiencies in either the installation or operation of HVAC systems. This process is actually a management control system, which is intended to provide a structured approach for checking the installation and operation of newly constructed HVAC systems and the automatic controls associated with these systems. Given the complexity of these systems, there is a recognized need to use an organized, systematic approach in this effort. TABS/ACATS/DALTS has been put into practice by NAVFAC ATLANTIC/PACIFIC to fill this need.

TABS/ACATS/DALTS are both acronyms. "TABS" is short for "Testing, Adjusting, Balancing and Start-up." The name is derived from the tasks that are a part of the overall checkout of the “HVAC” “Heating, Ventilating and Air Conditioning” systems. Similarly, "ACATS" is short for "Automatic Controls Acceptance Tests," which refers to the series of tests the installed automatic controls undergo during the overall process. “DALTS” is short for “Duct Air Leakage Tests”, which refers to the series of tests that are performed on the installed ductwork to confirm that the leakage rate does not exceed the allowable leakage rate for the seal class and construction of the specific duct to be tested.

In summary, TABS/ACATS/DALTS is a process, which, in an organized, systematic way, ensures the proper installation of HVAC systems and confirms that the equipment is functioning to its intended level of performance.

WHY IS TABS/ACATS/DALTS UTILIZED?

The primary reason for utilizing TABS/ACATS/DALTS is to significantly reduce the problems experienced with HVAC systems after the facility is occupied and to provide a means for reacting quickly to resolve problems when they are encountered. Our first interest must be to minimize, to the greatest possible extent, operational disruptions, inconvenience, or discomfort for our customers.

In the past, NAVFAC ATLANTIC/PACIFIC has experienced problems with installed HVAC systems associated with new construction. More often than not, these problems were not discovered until after the facility had become fully occupied and operational. At times, these problems were so severe as to cause major disruption of facility operations and high levels of customer dissatisfaction. On investigation, these situations were usually found to be the result of several elements.

Construction deficiencies were found to be a major contributing factor. Problems such as improperly installed ductwork, piping, and equipment were appearing frequently. By utilizing the TABS/ACATS/DALTS process, many of the construction deficiencies can be discovered during construction and prior to facility occupancy. This provides an opportunity to reduce the number of problems experienced after occupancy and to minimize their severity when they do occur.

Design mistakes have also proven to be a common source of problems. Misinterpretation of operational needs and design errors/omissions are frequently encountered. Items such as undersized piping/ductwork, under-sizing of fans/pumps, and incorrect cooling load estimates do occur. TABS/ACATS/DALTS assists in identifying such problems and helps facilitate a course of action for making corrections.

TABS/ACATS/DALTS is very helpful in quickly differentiating between design and construction deficiencies when a problem is encountered. The field data, which is compiled during TABS/ACATS/DALTS, is invaluable in evaluating a problem and assigning the problem to the appropriate party for correction. Much wasted time can be avoided in deciding who has ownership of a problem. Problems can be resolved more quickly as a result.

TABS/ACATS/DALTS is effectively used in providing feedback for continuing change and improvement to design criteria. The information compiled during the process helps identify areas that require improvement and those design features, which are working well. This gives us the advantage of being able to prepare our designs based on previous successes while avoiding past mistakes.

Improved operating efficiency of the systems will result if they are installed properly. If the water and air volume flow rates intended by the design are attained and the automatic controls systems are properly functioning, it is much more likely that efficient operation can be attained. TABS/ACATS/DALTS contributes significantly in meeting this objective. Improved operating efficiency results in financial savings to the user over the entire life of the installed systems.

The TABS report provides a very effective planning document for use in evaluating any future changes to the mechanical systems.

WHAT ARE THE LIMITATIONS OF TABS/ACATS/DALTS?

This process will not achieve a "zero defect" condition. Economic considerations and time restrictions do not, as a matter of practicality, allow a regimen of quality control and quality assurance that would give us that capability. As a practical goal, we set as an objective to minimize problems being identified after facility occupancy.

TABS/ACATS/DALTS is normally conducted just prior to contract completion and in advance of facility occupancy. Problems, which are the result of the design not fully satisfying operational needs, may not become apparent until after occupancy. For example, a computer complex which is outfitted with far more equipment than had been anticipated by the designer will not be evident until after the computer equipment has been made operational. However, the process does assist with such situations by providing the necessary field data to set a corrective plan of action in place quickly. Our reaction time in responding to such problems is decreased as a result.

TABS verification tests/inspections are not contractually required for one hundred percent check of all systems installed. Instead, verifications are conducted on a representative sample basis for each of the system types installed. For example, if ten air handling units were installed on a given project, the contract specifications may dictate that only three of the units are to undergo verification tests. This leaves the possibility that latent problems may remain undiscovered on those units that are not checked. However, statistically, the probability of problems being encountered are reduced.

TABS/ACATS/DALTS is conducted in a given season (winter/summer) just prior to facility occupancy. Some problems may not express themselves until a later seasonal condition exists. As an example, if an air conditioning system was installed on a project, which is initially tested during the winter, operational problems may not be identified until the following summer.

In summary, unrealistic expectations can be avoided if it is understood that there are certain risks that remain with regard to the TABS/ACATS/DALTS process. The process greatly reduces the probability of major problems and provides a vehicle for promptly responding to problems when they arise. "Zero defect" should not be seen as a realistic goal.

TAB A

TABS: MAJOR ELEMENTS

TABS: MAJOR ELEMENTS/SUBMITTALS/WORK ACTIVITIES

The following provides a detailed description of the overall TABS process. So far, we have discussed TABS on a level of generalities. We will now proceed to discuss all major elements of the process as typically identified by Specification Section 15950. We will also review how those elements relate to each other. This will include a description of the submittals required and how they are used. Also, we will discuss the work activities involved. They will be presented in sequential fashion representative of the order in which the processes normally would take place.

MAJOR ELEMENTS OF TABS

- The services of a TABS Agency are procured to properly balance the air and water systems associated with the installed HVAC systems.
- A design review is conducted by the TABS Engineer to minimize future rework resulting from errors.
- A thorough test is conducted on all of the automatic controls systems to confirm that the correct control sequences have been attained, to ensure that the controls are properly calibrated, and to exhibit repeatable/stable control characteristics.
- The installed equipment is monitored to ensure proper performance. Heat transfer data is compiled and reported for equipment to determine whether it is operating at levels that are satisfactory. Also, equipment operational data, such as motor amps and fan speed, is compiled and confirmed to be in an acceptable range.
- Any construction deficiencies or design problems that are identified during the course of TABS efforts are corrected prior to project completion where practical.
- Sound level readings are taken within the conditioned spaces to confirm that the mechanical systems are not creating noisy conditions for the facility occupants.
- Any problems requiring change in design criteria for future projects are compiled and forwarded, with recommendations, to NAVFAC ATLANTIC/PACIFIC CI43.

TABS SUBMITTALS AND WORK ACTIVITIES

Step 1 (Qualifications Submittal) - A qualifications submittal is required shortly after contract award. This submittal must provide documentation to demonstrate the experience level, formal training, and experience of the TABS Agency and its personnel. The specific individuals that will work on the project are identified, and a resume of their training/work experience is provided. The purpose is to ensure that the TABS Agency and the personnel that they intend to use are sufficiently qualified to properly conduct the TABS work effort. The TABS Agency plays an important role in the overall process. They must have a diverse and in-depth knowledge of HVAC systems if they are to do an effective job.

Step 2 (Pre-TABS Meeting) - A Pre-TABS Meeting is normally required on larger, more complex projects early after the TABS qualifications submittal has been approved. The purpose of this meeting is to ensure that the Contractor and the Government have a mutual understanding of the scope of work for the TABS effort and to resolve any existing misunderstandings very early in the process. The prime Contractor, his CQC staff, the Sheet Metal Contractor, the Electrical Contractor, the Mechanical Contractor, the Automatic Controls Contractor, and the TABS Engineer are required to be in attendance. This meeting provides a very opportune time to set the proper tone and to convey a seriousness of intent to all of the participants. It also provides the opportunity for encouraging a team approach and selling the Contractor on the importance of regular coordination meetings.

Step 3 (Design Review Report Submittal) - Once the Agency qualifications have been approved, the TABS Engineer, assigned by the TABS Agency, is required to conduct a thorough review of the project plans and specifications. The purpose of this review is to identify anything inherent to the design, which would prevent the HVAC systems from being successfully TAB'D. Examples of items which might be identified as deficient would be the absence of balancing dampers in ductwork, missing or improperly placed balancing valves in water piping, or inadequate access to equipment to allow balancing to be conducted. The intent of this submittal is not to require the review of less obvious design features, such as adequate pipe or duct sizes. On completion of his review, the TABS Engineer is required to submit his findings in a report. It is commonplace to issue a modification to incorporate needed changes into the contract as a result of the design review report. We wish to emphasize the importance of obtaining this submittal as soon as possible. If needed changes are identified early, it is relatively easy and inexpensive to get them incorporated. On the other hand, if the Contractor is allowed to submit this report late, it can result in significant delays, rework, greatly increased costs, and high frustration levels for all parties.

Step 4 (Pre-field Engineering Report Submittal) - The key to conducting a successful TABS process is preparation and planning. To that end, the TABS Engineer is required to prepare a report, which thoroughly documents his entire scope for implementation of fieldwork. Step-by-step procedures are provided describing what systems are to be TAB'D, what procedures are to be used for each system, the instrumentation that will be used in each case, and the order in which the work will be conducted. A complete set of the intended final TABS report sheets is included showing all data that will be submitted on completion of the TABS fieldwork. The primary purpose of this submittal is to encourage the Contractor to be fully prepared on arrival at the jobsite to conduct his fieldwork. It is also intended to provide the Government, in advance, with a description of the Contractor's intended scope of work. Any misunderstandings with regard to scope of work can be resolved in advance of the TABS Engineer completing his fieldwork, demobilizing, and submitting his final TABS report. This helps prevent a situation, which would require the Contractor to remobilize to the jobsite for compiling any additional data that may have been overlooked. It helps to avoid loss of Contractor profits, loss of valuable time, and maintains a positive working relationship between the Contractor and the Government.

The Contractor is also required to submit a blank prerequisite checklist with the submittal. This checklist is a standard checklist, which has been prepared by the National Environmental

Balancing Bureau (NEBB). Its function is to provide an outlined plan for use by the prime Contractor in coordinating the many work activities that have to be completed by several trades before the TABS Engineer can begin his fieldwork. These checklists are turned over to the prime Contractor who is then expected to act as a project manager to ensure that the checklists are filled in. The work is then certified to be complete for each HVAC system before the TABS Agency is asked to start their fieldwork.

Many projects contain a requirement in Specification Section 15950 to conduct TABS in two different seasons, Season I and Season II. The two seasonal TABS are required to be conducted during seasons of maximum heating load and maximum cooling load. The intent of this requirement is to be able to examine how well the systems are performing under the two seasonal extremes that they will typically encounter. These seasons of maximum load are defined to occur when actual outside air temperatures are sufficiently close to the design outside air temperatures indicated on each project's construction drawings. So as not to be overly restrictive to the Contractor, the specifications allow the TABS work to be conducted over a range of allowable outside air temperatures. These ranges are normally plus or minus 15 degrees Fahrenheit for maximum cooling load and plus or minus 30 degrees for maximum heating load. We wish to emphasize that this constraint applies only to heat transfer performance data and to equipment that cannot be operated during a given season of TABS for risk of damage. Normally, water and air proportionate balancing may be conducted under any seasonal extreme. The Contractor is expected to clearly identify all work activities that will be conducted under each respective season as part of the Pre-field Engineering Report Submittal.

Step 5 (Season I Pre-requisite Checklist Submittal) - Once the work has been completed for each respective HVAC system and the prerequisite checklists have been completed as described above in Step 4, the project is then ready for field mobilization by the TABS Contractor. Prior to mobilization, the prime Contractor submits the completed checklists, which are signed and certified attesting to the completion of the work in total. After review and approval of the checklists, the TABS Agency is authorized to proceed with the fieldwork. The submittal also provides notification of the date on which the TABS Engineer will commence fieldwork. The Contractor is required to provide notice of the date when TABS work will commence to ensure from a quality assurance standpoint that all preparations have been satisfied.

We wish to emphasize the importance of enforcing this submittal and insisting that it be properly implemented and taken <u>very seriously</u> by the Contractor.

TABS Agencies have conveyed to the Command that proper use of the prerequisite checklist is critical to success in implementation of TABS. This checklist is felt to be a valuable tool for effective coordination of trades that ensures efficient use is made of the TABS Engineer's time. They expressed the opinion that proper use of the submittal is frequently abused. We should seek to avoid such occurrences.

Step 6 (Season I TABS Field Work) - Once the prerequisite checklist has been completed and submitted, the TABS Agency is free to proceed with the fieldwork. Typically, at this point, several work activities will occur. All air and water systems will be proportionately balanced, and the appropriate seasonal performance data will be compiled and incorporated into a final report. During the course of fieldwork, the Contractor is required to report immediately any deficiency, which is perceived to be design related. The matter is then evaluated by NAVFAC ATLANTIC/PACIFIC or the project A-E, as appropriate, and recommendations are forwarded to the ROICC for making the necessary corrections. On completion of the fieldwork, the TABS Engineer will compile all field data into a final report. Once all of the data has been checked to ensure accuracy and completeness, the report is certified by the TABS Engineer. The Agency's seal and TABS Engineer's signature are affixed to the report.

Step 7 (Season I Certified TABS Report) - It is emphasized that all TABS submittals are forwarded directly to NAVFAC ATLANTIC/PACIFIC for review, including both in-house and A-E designs. The reports are examined for completeness and for conformance to the scope defined by the Pre-field Engineering Report (Step 4). The data is examined to determine whether any
deficiencies are apparent that have not been identified by the TABS Engineer in the report body.

If no omissions or errors are identified which are of a significant nature, the report is forwarded to the ROICC with review comments affixed. The Season I TABS field check can then be scheduled.

Step 8 (Season I TABS Field Check) - The TABS field check is a Quality Assurance function. Representatives of the Government meet the Contractor at the jobsite for the purpose of giving the Contractor the opportunity to demonstrate the accuracy and repeatability of the data contained within the certified TABS report. This function is used for conducting the final approval of the TABS work. Data to be checked is selected by the Government Representative in attendance. Up to twenty-five percent of the reported data may be checked during the testing. During testing, the Contractor is expected to provide all instrumentation and to conduct tests in the same fashion used during data compilation for the final report. If the Contractor repeats the results of the original reported data within tolerances of plus or minus five percent, the test is acceptable. For data, which cannot be repeated to the stated tolerances, the system being tested is subject to disapproval. If a sufficient number of points of reported data fails to meet the required tolerances, the entire report is subject to disapproval at the Government Representative's discretion. It is emphasized that, as a matter of policy, complete disapproval of a report should only be exercised under extreme conditions. In most cases, it is advantageous to both parties to allow the Contractor to provide supplemental data for the out-of-tolerance systems after they have been corrected. Re-testing of out-of-tolerance systems should, as a matter of policy, be conducted after supplemental data has been submitted.

NOTE: This is the single most important activity associated with the TABS process. The field check should always be conducted. Also, a Government Representative should always be in attendance. Utilize CI52 personnel to the maximum extent possible for this purpose. Try to provide a minimum of ten days' advance notice to CI52 when possible. Every effort will be made to accommodate shorter notice, but this may not always be possible.

Step 9 (Season I TABS Completion) - On successfully completing the Season I Field Check, the Contractor is required to permanently mark all balancing dampers and balancing valves to show their final balanced position. All test ports installed in the ductwork are checked and verified to have been plugged, and the duct insulation is reinstalled over the test port locations. The test port locations in the ductwork are permanently marked on the insulation exterior for future location/use. The TABS Engineer will have, at that point, satisfied all contractual requirements, which must be met prior to the specified contract completion date. The remaining Season II TABS work is carried as a punch list item, which must be completed prior to the close out of the contract. Liquidated damages are never assessed against Season II work.

Step 10 (Season II Prerequisite Checklist Submittal) - Prior to starting Season II field work, the Contractor is required to submit a completed prerequisite checklist as described above in Step 5. The checklist would address any systems which were not completed at the time of Season I evaluation. The following are provided as examples of systems that may require a Season II for completion of TABS:

- Air handlers, equipped with six to eight row coils and very close coil fin spacing, can experience significant increases in air friction pressure drop when operating under wet coil conditions as compared to dry coil conditions. This can result in unacceptably low airflows being attained under wet coil conditions. For a project where the first season TABS occurs in the winter, it would be desirable to conduct final airflow balancing during the following summer when wet coil conditions can be attained.

- Some air conditioners, which are not equipped with special optional features, cannot be operated in the winter during periods of cold weather as the equipment may be damaged. The equipment would have to be operated in the following summer season to verify proper operation.

As with equipment TAB'D during the Season I TABS, the Contractor should confirm the installation and preparation are completed prior to allowing the TABS Engineer to commence work.

We wish to emphasize that a recurrent problem of marginal maintenance has been encountered in attempting to conduct Season II fieldwork. The Contractor's ability to conduct the second season work is dependent upon a properly applied preventive maintenance program after facility turnover. It is the Government's responsibility to ensure that the Contractor can conduct his fieldwork when he arrives at the jobsite. It is highly recommended that the ROICC conduct an advance walk-through of the facility prior to the date of fieldwork commencement to ensure that the work efforts will not be delayed due to such items as dirty filters, broken fan belts, and equipment breakdowns caused by marginal maintenance. Where such problems are encountered, they should be corrected before the TABS Engineer comes to the jobsite.

Step 11 (Season II TABS Fieldwork) - As in Step 6, once the prerequisite checklist is completed, the TABS Engineer may proceed with the second season fieldwork**.** Normally, the second season scope of work contains very little balancing work, as the majority of systems would have been proportionately balanced during the first season fieldwork. The vast majority of data submitted will be heat transfer performance data. This will be used to evaluate whether the system appears to be performing to its intended level of performance under the given seasonal conditions.

Step 12 (Season II Certified TABS Report Submittal) - The data compiled during the second season TABS field work is placed into a final report which is signed and certified by the TABS Engineer much the same as described for Season I, Step 7. With submittal of the Season 11 Report, the Government then has a record of how the facilities' HVAC systems have performed under both seasonal extremes. This gives us a much better idea of how well the systems are performing over the full range of load demand. Significantly, the second season work effort provides an opportunity to receive firsthand input from the facility occupants, as the facility is normally occupied by the time second season field work is conducted. This often provides valuable information as to how the systems are perceived to be performing from the customer.

Step 13 (Season II TABS Field Check) - The field check for Season II is conducted in the same manner as described for Step 8, Season I Field Check. The tolerances for acceptance of test data remain the same as prescribed for Season I.

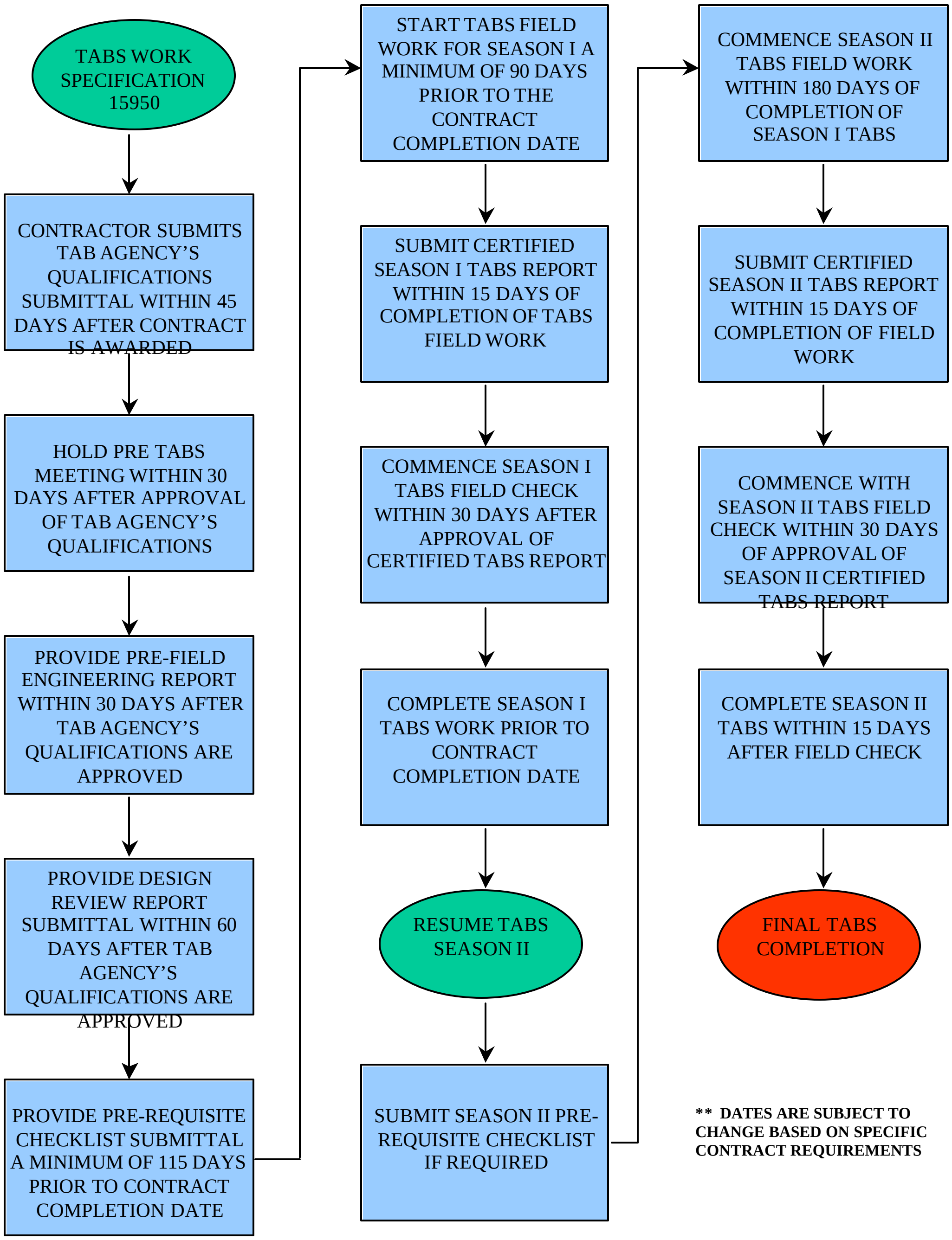
Step 14 (Season II TABS Completion) - Upon successful completion of the Season II field check, all test ports, duct insulation patching, and permanent marking of balancing devices are accomplished much the same as described by Step 9 above.

TABS- SUMMARY OF THE OVERALL PROCESS

The information provided in this handbook is typical for nearly all projects. However, we highly recommend that you consult the specifications for the specific project in question when determining contractual requirements. There have been several generations of specifications used for TABS, and it is commonplace to find variations in the contractual requirements. Always consult with the job specific specifications when administering the contract.

The following flow chart is used to provide a quick reference and summarize the overall TABS process.

TABS OVERALL PROCESS



**** DATES ARE SUBJECT TO CHANGE BASED ON SPECIFIC CONTRACT REQUIREMENTS**

TAB B

TABS AGENDA EXAMPLE

TABS

DESIGN REVIEW REPORT
&
PRE-FIELD ENGINEERING REPORT

EXAMPLES

DESIGN REVIEW REPORT & PRE-FIELD TAB ENGINEERING REPORT

ATLANTIC DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
NORFOLK, VIRGINIA 23511-6287

APPROVED
APPROVED AS NOTED
DISAPPROVED
SUBJECT TO THE REQUIREMENTS OF
CONTRACT NO.
APPROVAL OF A SUBMITTAL DOES NOT INCLUDE APPROVAL OF ANY DEVIATION FROM THE CONTRACT REQUIREMENTS UNLESS THE CONTRACTOR CALLS ATTENTION TO AND SUPPORTS THE DEVIATION — THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING PROPER PHYSICAL DIMENSIONS & WEIGHTS, COORDINATION OF TRADES, ETC., AS REQUIRED.

REVIEWER DB DATE 14 MAR 1997

FOR OFFICER IN CHARGE OF CONSTRUCTION

February 4, 1997

Chesapeake, VA 23323

PROJECT: Design Review Report

Gentlemen:

In accordance with the specification Section 15996/1 .4.1.2, we have completed our review of the plans and specifications for this project. We have listed herein questions and observations based on the contract drawings:

1. There are some discrepancies on the CFM values for the Terminal units vs. the diffuser/grille totals. Unless otherwise directed we will adhere to values listed on M2. The supply air diffusers or return air grilles will be adjusted proportionately to match the values as shown on the terminal unit schedule. (Examples are: TU-3,9,11,17,27,28,29,30 & 32)

2. Our total of all the return air grilles and the minimum outside air for AHU-1 is 12740 CFM. The unit is designed for 10600 CFM. Please advise.

3. Our total of all the return air grilles and the minimum outside air for AHU-2 is 5840 CFM. The unit is designed for 3300 CFM. Please advise.

4. Our total of all the return air grilles and the minimum outside air for AHU-3 is 19765 CFM. The unit is designed for 19400 CFM. Please advise.

5. Our total of all the return air grilles and the minimum outside air for AHU-4 is 1780 CFM. The unit is designed for 1820 CFM. Please advise.

6. Our total of all the return air grilles and the minimum outside air for AHU-5 is 1610 CFM. The unit is designed for 1660 CFM. Please advise.

7. Our total of all the supply air diffusers for AHU-5, is 1690 CFM. The unit is designed for 1660 CFM. Please advise.

8. Our total of all the supply air diffusers for AHU-6 is 665 CFM. The unit is designed for 640 CFM. Please advise.

9. Our total of all the return air grilles and the minimum outside air for AHU-6 is 625 CFM. The unit is designed for 640 CFM. Please advise.

PRE-FIELD

ENGINEERING

REPORT

Step-By-Step
TAB Procedure

2/4/97

Contract: N62470 .` ι'`

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1. TAB ENGINEER'S SITE VISIT/SURVEY

1.1. AJR

1.1.1. During the construction phase, visit the project site if requested to observe installation of ductwork, dampers, VAV boxes, grilles, diffusers, etc. Also, look at the application of insulation to make sure that any damper adjustment devices are not covered over.

1.1.2. During the walk-thru, observe building for completion of structure (installed doors, windows, ceilings, etc)

1.1.3. Observe ductwork for completion and all dampers open, splitters in mid position and all grilles/diffusers installed. Also, check fire dampers. These items are included in the prerequisite checklist and it is the responsibility of the Sheet Metal Contractor to assure that these items are properly installed.

1.1.4. Determine if the system has been inspected for leakage. Specifically request that access doors and hardware, coils, pipe penetrations, and duct connections have been properly sealed (in accordance with the specifications).

1.15. Observe ootdoor air louvers for obstructions.

1.1.6. Insure that all air handling equipment is operable and filters are installed and-clean.

1.2. WATER

1.2.1. During the construction phase, visit the project site if requested to observe installation of piping, flow control valves, circuit setters, etc. Request that the Mechanical Contractor install all flow sensors and circuit setters in accordance with manufacturer's instructions. Also, look at the application of insulation to make sure that the flow control adjustment devices are not covered over.

1.2.2. Observe system to insure all valves open to heat exchange elements (i.e., coils, etc.).

1.23. Request that system hi points be vented to iusure that the system is not air locked.

1.2.4. Check water for cleanliness. If system water is found to be dirty, advise appropriate contractor.

2/4/97

Contract: N62470

5. COMPLETED PREREQUISITE CHECKLIST

5.1. The TAR Engineer will visit the project site to meet with the Project Superintendent for the purpose of assisting him in the completion of the Prerequisite Checklist During this site visit, the TAB Engineer will explain the TAR process and identify any problem areas which may remain noticeable.

6. SUBMIT NOTICE OF COMMENCEMENT OF TAR FIELD WORK

6.1. Letter is issued to Prime Contractor with date of Commencement of TAR Field tests. Any support, known to be required by the TAR Agency at this time, will be included in this letter.

7. FAN SYSTEM TESTING & ADJUSTMENT

AHU-1 thru AHU-5, RTU-1, CRU-1, 2, HP-l,2

Measure / Report for both peak mechan Cooling & economizer Cooling airflows - where Applicable

7.1. Prerequisite Checklist must, be completed before starting this task

7.2 Check unit for internal cleanliness, removal of foreign material, and casing tightness.

7.3. Check filters for cleanliness and proper installation. Record size and quantity.

7.4. Check cogs for cleanliness and removal of foreign material.

7.5. Observe damper sequences, if installed for proper operation. Set in desired fixed position prior to balance.

Confirm accuracy of air flow measuring station calibration.

7.6. "Rump" fan and observe for proper rotation.

7.7. Record fan nameplate data.

7.8. Compare the data on the fan nameplate to the manufacturer's submittal data. This confirms that the correct equipment has been furnished and is installed in the correct location.

7.9. Record motor nameplate data.

7.10. Read and record motor voltage, amperage and RPM [Amprobe . Volt/Amp meter]

7.11. Read and record San RPM. [Electronic Tachometer]

7.12. Determine CFM delivery. (Pitot tube traverse, or diffuser total). [Manometer and/or Flow Hoods]

7.13. Adjust static pressure controls and/or sheaves to achieve required CFM. (Observe motor amps if increasing CFM.) [Amprobe Volt/Amp meter] so that maximum air flow is to another zone or area. Repeat the above steps with the new VAV boxes on full cooling.

8.9. With the system operating on maximum return air and minimum outside air, determine the total return airflow by pitot tube traverse (if possible). Measure and adjust for proper minimum outside air quantity. Adjust the fan speed for design requirements and balance the return system.

9. EXHAUST FANS

EF-1 THRU 14, F-l

9.1. Determine the volume of air being moved by the exhaust fan at design RPM by pitot tube traverse or diffuser total. [Electronic Manometer or Flow Hoods]

9.2. Record the exhaust fan suction static pressure, amperage and CFM measurements. Confirm that the fan motor is not overloaded. [Electronic Manometer or Magnehelic Gauge.]

9.3. If the CFM measurement varies more that 10% from design, adjust the drive of each fan to obtain the approximate required CFM.

9.4. Measure and record the airflow at each exhaust grille in the system. Study any radical condiioas and correct them. [Electronic Flow Hoods]

9.5. Working from the branch with the highest measured capacity to the branch with the lowest measured capacity, make adjustments in each branch. Beginning with the inlet device most distant from the branch connection, make volume adjustments at each grille as necessary.

9.6. Repeat the branch balancing until the system is in balance.

10. PITOT TUBE TRAVERSES

10.1. Locate traversable duct and clear access to duct,

10.2. Measure duct to determine net area. Drill holes in desired locations if not provided by others (per contract specifications).

10.3. Identify the location of the duct test ports and attach label to ductwork or on external insulation.

10.4. Set up instrument, take desired number of readings, determine average velocity, secure instrument [Electronic Manometer]

13. **TERMINAL UNITS [VAV Boxes)**

TU-1 THRU 34

13.1. **Determine proper number of boxes to be set to full cooling** based on **system diversity prior to testing.**

13.2. **Read static pressure at the supply to unit, to insure sufficient static for unit to operate. (Read the terminal units furthest from fan, any others in obscure locations where low static pressure conditions may exist).**

13.3. **Determine CFM delivery by terminal unit with unit calling for full cooling or full heating. (Pitot** tube traverse **or diffuser total). [Electronic Manometer or Flow Hood]**

13.4. Adjust volume regulator to achieve design CFM, as required.

13.5. Adjust unit to proper minimum flow condition.

13.6. Mark and record volume regulator's final set position.

14. GRILLE & DIFFUSER TESTS & ADJUSTMENTS

Supply diffusers type A thru I
Exhaust/Return registers type P thru Z

14.1. Determine CFM delivery or removal of each outlet/inlet. [Electronic air flow hoods]

14.2. **Note: When using flow hoods for balancing diffusers, grilles, etc., the hood reading (along with the backflow compensation factor) will be used to determine a correct flow factor. The correction factor will be applied to compensate for errors in throw patterns, etc unique to certain types of diffusers/grilles.**

14.3. Adjust manual volume damper(s), opposed blade dampers and fan capacity (not to exceed motor amperage) as necessary to achieve desired CFM.

14.4. Proceed in a systematic manner.

15. **UNIT** HEATERS

UH-1 THRU 6

15.1. Verify that the units art piped correctly including required valves, vents and safety devices.

15.2. **Confirm that provisions are available for making the required temperature and pressure measurements.**

which arc high and which are low in water flow. [Manufacturer's approved method using Calibrated Test Gauge]

17.3. Make a preliminary adjustment to the balancing cocks on all units with high water flow, setting each about 10% higher than the design flow rate.

17.4. Take another complete set of pressure, voltage and amperage readings on all pumps in the system. If system total flow has fallen below design flow, open the balancing cock at each pump discharge to bring the flow at each pump within 105 to 110% of the design reading (if pump capacity permits).

17.5. Make another adjustment to the balancing cocks on all units which have readings more than 10% above design flow in order to increase the flow through those units with less tban design now.

17.6. Repeat this process until the actual fluid flow through each piece of equipment is within plus or minus 10% of the design flow.

17.7. Make a final check and record the amperages, pressures and the flows of all pumps and equipment

17.8. Where three-way automatic valves are used, set all bypass line balancing cocks to 90% of the maximum demand through coils.

17.9. Record setting of balancing valves and/or adjust lock to limit opening of balancing valve.

18. CONDENSING UNITS

- witness all readings
- validate instrument calibration
- conduct after water/air balance

CH-1

18.1. Read and record applicable data under proper seasonal load conditions. Any refrigeration data required (i.e., pressures, total charge, etc) will be provided by a Service Representative of the unit manufacturer. This is to be considered "additional support required" as outlined in tbe specification.

19. HOT WATER BOILER

B-l

19.1. Record nameplate data.

19.2. Prerequisite Checklist must be completed before starting this task

19.3. Establish full design water flow through boiler.

Flow Station Test Report
Temperature Test Report
Compressor/Condenser Test Report
Sound Level Report
Air Duct Leakage Test Summary
Instrument Calibration Report

22. Data will be provided on the above listed forms as applicable to the contract specification. Sample forms attached.

23. REPORT SUBMITTAL

23.1. Copies of the completed report are provided to the contractor along with a letter of transmittal.

24. FIELD DATA CHECK (1st Season)

24.1. Scheduled by the contractor, the TAB agency will return to the project to verify readings in the TAR report

25. MARKING OF SETTING

25.1. Permanently mark the settings of HVAC adjustment devices including valves, splitters and dampers so that adjustment can be restored if disturbed at any time.

26. SECOND SEASON TESTING

26.1. The contractor will schedule for the TAB agency to return to the project to test the alternate equipment under design season conditions.

27. REPORT OF SECOND SEASON TESTING

27.1. Prepare and submit a report of the second season testing process and identify any problem areas found.

End Of Section

FORM 01

AIR HANDLER UNIT TEST REPORT

PROJECT: ______________________ LOCATION: ______________________

SYSTEM: AHU- 1 ______________________ . EQUIP. LOCATION: ______________________

FAN MANUFACTURER: ______________________

MODEL OR SERIAL NO: ______________________

KEY		DESIGN	ACTUAL
@2	TOTAL CFM	10,600	
@2	MIN. O.A. CFM	1120	
@2	RETURN CFM	9480	
@2	DISCHARGE PRESS.	---	+. "
@2	SUCTION PRESS.	---	-. "
@2	EXT. FM STATIC PRESSURE	1.3"	. "
@5	FAN RPM	742	
--	FAN PULLEY	---	
--	BELT QUANTITY/SIZE	---	
--	FILTERS/SIZE	---	

MOTOR MANUFACTURER: ______________________

MODEL OR SERIAL NO: ______________________

KEY		DESIGN	ACTUAL
--	MOTOR H.P.	10	
--	FRAME	---	
@1	AMPERAGE		L2 L2 L3
@1	VOLTAGE		
@5	RPM		
--	MOTOR SHEAVE	---	
--	S.F.	---	
--	DATE OF TEST	---	/ /

REMARKS:

DATE: ______________________ BY: ______________________ SHEET: ________

FORM 07

AIR OUTLET TEST REPORT

PROJECT: ______ LOCATION: ______

SYSTEM: Terminal units (AHU-1) AREA SERVED: First ad -

AREA SERVED	OUTLET NO.	OUTLET TYPE	OUTLET SIZE	OUTLET K	DESIGN CFM	DESIGN UCFM	PRELIMINARY UNCORRECTED CFM *		FINAL UCFM *	FINAL CFM	REMARKS
TU-1	1	B	10"ø		210						
	2	B			215						
	3	B			270						
	4	B			270						
	5	C	? 15"ø		430						
	6	R			2-3 125						Return
	7	R			125						
	8	T			250						
	9	T			200						
TU-2	1	B			225						
	2	B			225						
	3	T			225						Return
TU-3	1	A			120						
	2	A			120						
	3	F			145						Return
DATE OF TEST	—	—	—	—	—	—	—	—	/ /		

REMARKS: * Uncorrected CFM. NOTE: All data on this sheet measured using Flow Hood.

DATE: ______ BY: ______ SKEET: ______

FORM 07

AIR OUTLET TEST REPORT

PROJECT: ____________________ LOCATION: ____________________

SYSTEM: Terminal Units AREA SERVED: 1st Floor

AREA SERVED	OUTLET				DESIGN		PRELIMINARY UNCORRECTED		FINAL		REMARKS
	NO.	TYPE	SIZE	K	CFM	UCFM	CFM *		UCFM *	CFM	
TU-7	1	B	10"Ø		285						
	2	B			290						
	3	B			285						
	4	T	14x [illegible]		210						Return
TU-8	1	F	8"Ø		185						
	2	F	8"Ø		185						
TU-9	1	E	12"Ø		375						
	2	F	8"Ø		200						
	3	E	12"Ø		375						
	4	P			515						Return
TU-10	1	F	8"Ø		250						
TU-11	1	F	8"Ø		200						
	2				200						
	3				215						
	4				200						
	5				200						
DATE OF TEST	6 —	P —	—	—	550 —	—	—	—	/ /		Return

REMARKS: * Uncorrected CFM. NOTE: All data on this sheet measured using Flow Hood.

DATE: ____________________ BY: ____________________ SHEET: ________

FORM 07

AIR OUTLET TEST REPORT

PROJECT: ' ______________________ LOCATION: ______________________

SYSTEM: Terminal Units AREA SERVED: 1st Floor

AREA SERVED	OUTLET				DESIGN		PRELIMINARY UNCORRECTED CFM *		FINAL		REMARKS
	NO.	TYPE	SIZE	X	CFM	UCFM			UCFM *	CFM	
TU-14	1	H	8"Ø		235						
	2				230						
	3				235						
	4				235						
	5				230						
	6				235						
	7	I			150						
	8	H			235						
	9	F			250						
	10	S			500						
	11	S			500						
TU-15	1	E	12"Ø		240						
	2	E	12"Ø		240						
DATE OF TEST	—	—	—		—	—	—	—	/ /		

REMARKS: * Uncorrected CFM. NOTE: All data on this sheet measured using Flow Hood.

DATE: ______________________ B E ______________________ SHEET: ______

FORM 01

AIR HANDLER UNIT TEST REPORT

PROJECT: ______ LOCATION: ______

SYSTEM: AHU-2 EQUIP. LOCATION: ______

FAN MANUFACTURER: ______

MODEL OR SERIAL NO: ______

KEY		DESIGN	ACTUAL
@2	TOTAL CFM	3300	
@2	MIN. O.A. CFM	3020	
@2	RETURN CFM		
@2	DISCHARGE PRESS.	I--	+* "
@2	SUCTION-PRESS.	---	-. "
@2	EXT. FAN STATIC PRESSURE	1.2"	"
@5	FAN RPM	1764	
--	FAN PULLEY	---	
a-	BELT QUANTITY/SIZE	---	
--	FILTERS/SIZE	---	1

MOTOR MANUFACTURER: ______

MODEL OR SERIAL NO: ______

KEY		DESIGN	ACTUAL
--	MOTOR H.P.	3	
--	FRAME	---	
@1	AMPERAGE		L2
			L2
			L3
@1	VOLTAGE		
@5	RPM		
--	MOTOR SHEAVE	---	
--	S.F.	---	
--	DATE OF TEST	---	/ /

REMARKS:

DATE: ______ BY: ______ SHEET: ______

INSTRUMENT CALIBRATION REPORT

* KEY	[redacted]	MANUFACTURER / SERIAL	APPLICATION	REC[redacted] DATE	CALIBRATION TEST DATE
@1	Clamp-on Volt-Ammeter	Amprobe / DD7429244	Measure Current & Voltage	10/17/97	10/17/96
@2	Airdata Multimeter/ Electronic Micromanometer	Shortridge / M87294	Air Flow Measurement	10/21/97	10/21/96
@3	Magnehelic Guage (.5" Range)	Dwyer / W60930J056	Static Pressure Measurement	Each Use	Each Use
@3	Magnehelic Guage (1" Range)	Dwyer / W890517MP037	Static Pressure Measurement	Each Use	Each Use
@4	Magnehelic Guage (5" Range)	Dwyer / R900425G73	Static Pressure Measurement	Each Use	Each Use
@5	Photo Tachometer	Pioneer Electric / 0137	RPM Measurement	10/03/97	10/03/95
@6	Digital Thermometer	Fluke / 4655167	Temperature Measurement	10/03/97	10/03/95
@7	Sling Psychrometer	Bacharach / 1669	W.B. Temperature	None	None
@8	Pressure Gauge (0-30#)	Helicoid / HVAC-0-30-1	Water Pressure Measurement	10/04/97	10/04/95
@9	Pressure Gauge (0-60#)	Helicoid / HVAC-0-60-1	Water Pressure Measurement	10/04/97	10/04/95
@9	Pressure Gauge (0-200#)	Marshall / HVAC-0-200-1	Water Pressure Measurement	10/04/97	10/04/95
@9	Compound Gauge (-30-30#)	Helicoid / HVAC-30-30-1	Water Pressure Measurement	lo/w97	10/04/95
@9	Compound Gauge (-30-60#)	Helicoid / HVAC-30-60-1	Water Pressure Measurement	10/04/97	10/04/95
@9	U-Tube Manometer (36")	Dwyer / 1675	Water Pressure Measurement	None	None
@6	Sling Psychrometer	Bacharach	D.B. & W.B. Measurement	None	None
@4	U-Tube Manometer (24")	Dwyer / 1662	Air Pressure Measurement	None	None
@6	Mercury Thermometer (-30-120)	Taylor	Temperature (Immersion)	None	None
@6	Mercury Thermometer (0-230)	Taylor	Temperature (Immersion)	None	None
@6	Dial Thermometer (-40-160)	Ashcroft	Temperature (Air)	None	None
@6	Dial Thermometer (O-220)	Ashcroft	Temperature (Air)	None	None
	Pitot Tube (18")	Dwyer / 160-18	Air Pressure Measurement	None	None
	Pitot Tube (36")	Dwyer / 160-36	Air Pressure Measurement	None	None

REMARKS: * KEY: Instrument I.D. number used to denote instrument used for each particular test.

14 MAR 97

LANTOPS Code 0521 Review Comments
Submittal Transmittal #50,
Design Review Report and TABS Pre-field Engineering Report
Contract N62470

Design Review Report--Approved As Noted (AN). Your comments are currently being evaluated-direction will be provided under separate cover.

Pre-field Engineering Report-Approved As Noted (AN).

1. For all air handlers which have airside economizers, report airflows for both peak mechanical cooling mode and for peak economizer mode of control in accordance with NEBB procedures. Please be sure to include fan motor data for both modes, also.

2. Confirm the accuracy of the airflow measuring stations specified by measuring airflows and comparing readings with the monitor reported airflow measuring station readings. Include fmdings in the final report.

3. If condensing unit report data is provided by a service representative of the equipment manufacturer, the taking of such data shall be witnessed by either the TABS Engineer or the TABS Team Field Leader. The TABS Agency representative shall confirm the calibration of the instruments used and shall confirm that all report data is read and compiled ***after*** the water and air balance has been fully completed. It shall be the TABS Agency's responsibility to see that this data is taken in a timely manner in the appropriate season. Failure to conform to the above will result in report disapproval. In the future, please indicate your intent to comply with the above stipulations to avoid resubmittal action.

4. Typical for all terminal box report forms, please include fan CFM in the report for all series VAV terminal boxes. Also, if low primary or fan airflows are encountered, please report VAV box primary inlet static pressure and VAV box fan downstream static pressure/inlet static pressure. If low airflows are encountered during balancing, please notify the contracting officer's representative and request direction.

5. For all air handlers, in lieu of the proposed "temperature test report," please provide NEBB report form TAB 5-91 for all coil performance data reports.

6. The proposed key plans showing outlet number are too small for adequate legibility. Please provide plans of a larger scale--foldout pages will be acceptable.

TAB C

TABS CHECKLIST

PREREQUISITE

CHECKLIST

February 4, 1997

PROJECT: Prerequisite Work Required

Contract #: N62470 HVAC Job#:

Gentlemen:

In accordance with contract specifications, we are providing the attached "Prerequisite Checklist" and the following comments:

Prerequisite Work Required:

All mechanical equipment, ductwork and control systems should be installed and operational prior to the beginning of our balancing. The prebalance "checklist", provided attached, will allow the "Prime Contractor" to verify these items prior the start of TAB work. Completion of this list constitutes permission for the TAB Agency to operate the equipment, as needed, during the TAB testing.

The completed and approved "Prerequisite checklist" will be required to be **returned to the TAB agency <u>prior to the start of TAB work</u>. This checklist will** verify, in writing, that the items have been acceptably completed prior to the TAB Engineer arriving at the project site to begin tbe TAB work. Should any items be found to be incomplete or inoperative at the time of TAB work, charges for delays and repeated testing will be the responsibility of the company providing the completed prerequisite checklist.

Support Required:

In addition to the above, support may be required from other trades as outlined in the specifications (Coordination Of Supporting Personnel) during initial testing. This support includes, but is not limited to, assistance from equipment suppliers to provide installation and operation data, fan curves, etc. The temperature controls contractor will be required to verify proper controls operation prior to balancing and to achieve maximum demand conditions on all equipment. The Sheet Metal Contractor will be required to provide conditions as required for the duct leakage testing. The Mechanical Contractor may be required to provide a wet coil on all cooling units during portions of the TAB work. If problems are encountered during initial balancing, support will be required from the Mechanical Design Ehgineer and other trades such as electrical and sheet metal contractors to assist as outlined in the specification. The TAB agency will provide written notice to the contractor of these support requirements with as much lead time as possible.

In addition, support will be required to complete all construction as necessary to complete the Prerequisite Checklist in a time frame that will allow 28 days for fieid work and 15 days for report preparation prior to the specified contract compIetion. This time frame does not include any delays for advanced notices or other specified time frames.

We recommend that the conuactor coordinate with our office to allow our project manager to meet with the appropriate persons at the project site to assist in completion of the checklist.

Should you have any questions in this matter, do not hesitate to contact us.

Very truly yours,

PREREQUISITE CHECKLIST

PROJECT: ____________________________   **TAB CONTRACTOR: ____________________**

	READY YES	NO	DATE CORRECTED	CERTIFIED BY
(1) HVAC AND BUILD-UP UNITS				
a) General				
Louvers installed				
Manual dampers open and locked				
Automatic dampers set properly				
Housing construction leakage				
Access doors per plans & specs.				
Condensate drain piping & pan				
Free from dirt & debris				
Nameplate data clearly visible				
b) Filters				
Type / size / number correct				
Clean				
Blank-off plates installed				
Frame leakage at a minimum				
c) Coils (Hydronic – Water / Steam)				
Size & rows				
Fin spacing & condition				
Obstructions and/or debris				
Correct air flow direction				
Correct piping connections / flow				
Valves open & set				
Vents / traps installed correctly				
Provisions for TAB measurements				
d) Coils (Electric)				
Size & construction				
Airflow direction				
Duct connections				
Safety switches				
Obstructions				
Free from debris				
Contractors & disconnect switches				
Electrical service & connections				
Nameplate data clearly visible				
e) Fans				
Rotation				
Wheel clearance & balance				
Bearing & motor lubrication				
Drive alignment				
Belt tension				
Drive set screws tight				
Belt guards in place				
Flex duct connector alignment				
Proper unit / duct alignment				
Starters & disconnect switches				
Electrical service & connections				
Nameplate data clearly visible				

PREREQUISITE CHECKLIST

PROJECT: ____________________________　　　TAB CONTRACTOR: ____________________

	READY YES	/ NO	DATE CORRECTED	CERTIFIED BY
f) Vibration isolation				
Springs & compression				
Base level & free				
2) DUCT SYSTEMS				
a) General				
Manual damper open & locked				
Damper adjustments accessible				
Access doors closed & tight				
Fire dampers open & accessible				
Terminal units open & set				
Registers/diffusers open & set				
Turning vanes in square elbows				
Provisions made for TAB tests				
System installed per plans & specs.				
All ductwork sealed as required				
b) Architectural				
Windows installed & closed				
Doors closed as required				
Ceiling plenums installed/sealed				
Access doors closed & tight				
Air shafts/openings as required				
3) PUMPS				
a) Motors				
Rotation				
Lubrication				
Alignment				
Set screws tight				
Guards in place				
Tank level and controls				
Starters & disconnects				
Electrical service & connections				
b) Piping				
Correct flow				
Correct connections				
Leakage				
Valves open & set				
Strainers clean				
Air Vented				
Flexible connectors installed				
Provisions made for TAB tests				
System water clean				
c) Bases				
Vibration isolation				
Grouting (if required)				
Leveling				

PREREQUISITE CHECKLIST

PROJECT: ____________________________ **TAB CONTRACTOR: ____________________**

	READY YES	/ NO	DATE CORRECTED	CERTIFIED BY
4) HYDRONIC EQUIPMENT				
a) Boilers				
Operating controls & devices				
Safety controls & devices				
Lubrication of fans & pumps				
Draft controls & devices				
Piping controls & devices				
Valves set & open				
Water make-up provisions				
Blowdown provisions				
Electrical connections				
Nameplate data clearly visible				
b) Heat Exchangers				
Correct flow & connections				
Valves open or set				
Air vents or steam traps				
Leakage				
Provisions made for TAB tests				
Nameplate data clearly visible				
c) Cooling Towers/Evaporative Condensers				
Correct flow & connections				
Valves open or set				
Leakage				
Provisions made for TAB tests				
Sump water level				
Spray nozzles				
Fan/Pump rotation				
Motor/Fan lubrication				
Drives & alignment				
Guards in place				
Starters & disconnects				
Electrical connections				
Nameplate data clearly visible				
5) REFRIGERANT EQUIPMENT				
Crankcase heaters energized				
Operating controls & devices				
Safety controls & devices				
Valves open				
Piping connections & flow				
Flexible connectors				
Oil level & lubrication				
Alignment & drives				
Guards in place				
Vibration isolation				
Starters/Contactors/Disconnects				
Electrical connections				
Nameplate data clearly visible				

PREREQUISITE CHECKLIST

PROJECT: ____________________________ TAB CONTRACTOR: ____________________

		READY YES	/ NO	DATE CORRECTED	CERTIFIED BY
6) HYDRONIC PIPING SYSTEM					
	Leak tested				
	Fluid levels & make-up				
	Relief or safety valves				
	Expansion tanks & air vents				
	Steam traps & connections				
	Strainers clean				
	Valves open & set				
	Provisions made for TAB tests				
	Systems installed per plans & specs.				
7) CONTROLS & CONTROL SYSTEMS					
	Data centers				
	Outdoor/return Air/reset				
	Economizer set & tested				
	AHU Static pressure set				
	Room controls calibrated				
	VAV box regulators set to design				
	VAV box P.E. switches set				
	Proper end-of-line static pressure				
	VAV box reheats tested				
8) OTHER CHECKS					
	Appropriate contractors notified of TABS				
	Preliminary data complete				
	Test report forms prepared				

ADDITIONAL COMMENTS:

9) <u>NOTICE:</u>

Completion and submission of this form indicates that the mechanical systems are complete and installed in accordance with plans and specifications. Delays and/or additional testing required after system corrections and/or modifications will result in additional charges to the contractor.

Submission of this checklist also constitutes permission for the TAB Agency to operate the mechanical equipment, adjust sheaves, and motor speeds and control setpoints as needed during the performance of the testing and balancing.

PRIME CONTRACTOR: ____ DATE: ______________
MECHANICAL CONTRACTOR: _____________________________________ DATE: ______________
CONTROLS CONTRACTOR: ____ DATE: ______________
SHEET METAL CONTRACTOR: _____________________________________ DATE: ______________

TAB D

TABS VERIFICATION TEST PLAN EXAMPLE

6 February, 1998

TABS VERIFICATION TEST PLAN
QOL II Gymnasium
Contract N33 19 1-94-R-7003
U.S. Naval Support Activity, Capodichino
Naples, Italy
LANTOPS Construction Division
Darrell Larsen, Code 0521 Engineering Support Branch

I. Air Flow Testing

A. **Air Handler #1**

Preparatory:

Cl Verify air handler filters are clean

❑ Verify wet coil conditions exist for testing.

❑ Verify proper fan rotation

❑ Verify air handler is in occupied mode.

1. motor amperage/phase
2. motor voltage/phase
3. fan RPM
4. Supply duct traverse 600/600
5. Return duct traverse 7501500
6. Supply duct traverse 300 round, col 7-8/J-L
7. Supply Outlets
   a. CDE-E, col 7-8/G-J
   b. CDE-E, col 7-8/L-N
   c. CDE-E, col 4-5/L-N
   d. CDE-E, col 5-6/G-J

8. Return Outlets
   a. SR-A, col 4-5/G-J

9. Outside air traverse, 400/300, col 9-10/E-G, Dwg. GM4.11

10. Check back pressure compensation factors by traverse.

B. **Air Handler #2**

Preparatory:

Cl Verify air handler filters are clean

❑ Verify wet coil conditions.

Cl Verify proper fan rotation.

❑ Verify air handler is in occupied mode.

1. motor amperage/phase

2. motor voltage/phase

3. fan RPM

4. Supply duct traverse 650/350

5. Supply Outlets

   a. CD-D, col G-J/8-9
   b. CD-A, col E-G/5-6
   c. CD-A, col E-G/4-5

6. Check back pressure compensation factors by traverse comparison.

C. **Air Handler #3**

Preparatory:

Cl Verify air handler and VAV box filters are clean

❑ Simulate a peak demand condition on air handler. Review diversity setup if any.

Cl Verify proper fan rotation.

❑ Verify air handler/boxes are in occupied mode.

1. motor amperage/phase

2. motor voltage/phase

3. fan RPM @ peak demand

4. VFD frequency, hZ @ peak demand

5. measure downstream duct static pressure, compare to DDC reading.

6. Supply duct traverse 1000/500

7. Return duct traverse 1400/500

9. Outside air traverse 600/400 under peak demand conditions

10. Outside air traverse 600/400 under offpeak demand conditions, say 50% of peak primary.

11. VAV fan powered terminal boxes

a. Box #6 (col F-2, Dwg GM 2.13

(1) Max primary @ DDC, CFM/delta p

(2) Neutral pressure @ secondary

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

b. Box #7 (col E-2, Dwg GM 2.13)

(1) Max primary @ DDC, CFM/delta p

(2) Neutral pressure @ secondary

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

c. Box #8 (col J-3/4, Dwg GM 2.13)

(1) Max primary @ DDC, CFM/delta p

(2) Neutral pressure @ secondary

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

d. Box #9 (col J-2/3, Dwg GM 2.13)

(1) Max primary @ DDC, CFM/delta p

(2) Neutral pressure @ secondary

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

a. Box #1 1 (col C-D/3, Dwg GM 2.11)

(1) Max primary @ DDC, CFM/delta p

(2) Neutral pressure @ secondary

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

e. Box #14 (col D-E/4-5, Dwg GM 2.14)

(1) Max primary @ DDC, CFM/delta p

(2) Verify fan CFM exceeds max primary CFM

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

(5) Traverse of primary air duct at maximum primary

f. Box #15 (col E/4, Dwg GM 2.14)

(1) Max primary @ DDC, CPM/delta p

(2) Verify fan CPM exceeds max primary CPM

(3) Outlets @ Max primary

(4) Min primary @ DDC, CFM/delta p

(5) Traverse of primary air duct at maximum primary

B. **Air Handier #4**

Preparatory:

Cl Verify air handler filters are clean

❑ Verify wet coil conditions.

Cl Verify proper fan rotation.

❑ Verify air handler is in occupied mode.

1. motor amperage/phase
2. motor voltage/phase
3. fan RPM
4. Supply duct traverse 900 round
5. Supply duct traverse 850 round (col 4-5/C, Dwg GM 2.12)
6. Outside Air Duct traverse 400/250 (col A-B/4, Dwg GM 4.12
7. Supply Outlets (Dwg GM 2.12)

   a. col C-D/4-5
   b. col C-D/7-8
   c. col C-D/7-8
   d. col B-C/7-8
   e. col A-B/7-8
   f. col A-B/7-8

C. Exhaust fan # EF-2

a. motor amperage/phase

b. motor volts/phase

c. fan RPM

d. exhaust outlets

D. Exhaust fan # EF-4

a. motor amperage/phase

b. motor volts/phase

c. fan RPM

d. exhaust outlets

II. Water Flow Testing

A. Chilled Water Pump P-l

Preparatory:

❑ Confirm all fine mesh start-up strainers have been removed.

Cl Verify pump rotation.

1. motor amperage/phase

2. motor volts/phase

3. Pump no **flow** check **(be sure chiller is secured during this test)**

a. suction pressure

b. discharge pressure

c. check Vs. pump curve

4. Full Flow Check

a. suction pressure

b. discharge pressure

c.check Vs. pump curve

B. Chilled Water Flow Meter

1. Measure flow meter delta P w/differential pressure meter, check calibration curve.
2. Record DDC flow reading and compare with item **#1** flow.

C. AHU-1 Chilled Water Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM
5. by-pass flow

D. AHU-2 Chilled Water Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM
5. by-pass flow

E. AHU-3 Chilled Water Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM

5. by-pass flow

F. Air Cooled Water Chiller

1. Measure differential pressure AP across the chiller evaporator. Determine chiller flowrate using chiller manufacturer's flow Vs. AP data.

2. Measure and record the chiller entering and leaving chilled water temperature. Ensure stable water temperatures are being maintained.

G. Hot Water Pump **Primary** P-3

Preparatory:

❑ Confirm all fine mesh start-up strainers have been removed.

❑ Verify pump rotation.

1. Motor amperage/phase

2. Motor volts/phase

3. No flow check **(Check with boiler deenergized)**

a. suction pressure

b. discharge pressure

c. check Vs. pump curve

4. Full flow check

a. suction pressure

b. discharge pressure

c. check Vs. pump curve

E. VAV Reheat Coils

Box #	Valve size	Valve position	Valve AP	Flow, GPM	By-pass Flow
2					
7					
8					
9					
10					
12					
14					

F. AHU-1 Reheat Hot Water Coil

1. valve size

2. valve position

3. valve AP

4. flow, GPM

5. by-pass flow

G. AHU-2 PreHeat Hot Water Coil

1. valve size

2. valve position

3. valve AP

4. flow, GPM

5. by-pass flow

H. AHU-2 Reheat Hot Water Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM
5. by-pass flow

I. AHU-3 Hot Water Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM
5. by-pass flow

J. AHU-4 Hot Water Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM
5. by-pass flow

K. AHU-4 Pool Heat Recovery Coil

1. valve size
2. valve position
3. valve AP
4. flow, GPM

5. by-pass flow

L. Hot Water Boiler

1. Hot Water Boiler Supply Temperature

2. Hot Water Boiler Return Temperature

M. Hot Water Flow Meter

1. Measure flow meter delta P w/differential pressure meter, check calibration curve.

2. Record DDC flow reading and compare with item #1 flow,

TAB E

ACATS: MAJOR ELEMENTS

ACATS: MAJOR ELEMENTS, SUBMITTALS, AND WORK ACTIVITIES

The overall objective, installing HVAC systems which provide minimal problems after facility occupancy, has no chance for success unless the automatic controls, which have been installed in conjunction with these systems, are properly checked as part of the process. The efforts that are applied to quality control/quality assurance entail what we have previously referred to as Automatic Controls Acceptance Tests (ACATS). The installation of automatic controls systems is a complex business. The process usually entails the preparation of a performance specification by the project design engineers. These intricate sequence descriptions are then subjected to interpretation by the engineering staff of the installing controls manufacturer. A technician will then prepare field fabrication/installation drawings. In turn, an installing technician then makes an interpretation of the prepared drawings and installs the controls accordingly. It is not uncommon for projects to literally have miles of pneumatic tubing and/or control wiring installed to accomplish the myriad of controls functions and status functions involved. It should be concluded that with this chain-of-events comes much opportunity for the final controls to perform in a fashion other than had been intended by the designer.

Errors committed during installation, combined with misinterpretation of the original design philosophy, do create problems. The issue is further complicated when we consider that the original designers can, and do, make mistakes in the sequence of controls specifications provided. NAVFAC ATLANTIC has been conducting ACATS on their projects for an extended period of time. During that period, there has not been a single project encountered by Code 052 where mistakes in the controls systems installations have not been encountered. We wish to emphasize that this is not a condemnation of the controls industry but attests to the need for installed controls systems to be given careful attention with regard to quality control/quality assurance efforts. ACATS is used for that purpose.

To provide a better understanding of ACATS, the following will attempt to provide a detailed description of major elements, submittals, and work activities which make-up the process.

ACATS SUBMITTALS AND WORK ACTIVITIES

Prior to the final acceptance of the installed automatic controls systems, it is essential that a thorough testing of the systems be conducted. For testing to be effective, it must be preceded by careful preparation. There are many questions which must be answered. What controls components should be tested? What order should the control components be tested in?
How many modes of control are there for each control loop, or for each control subsystem, that are to be tested? What results of a given test sequence should be considered acceptable? Which controls should be tested for any special

requirements or unique application? These are all valid questions which come into play during testing. Attaining the correct answer to each requires that planning and careful deliberation be given to each of the systems involved. A carefully outlined plan prepared in advance of actually arriving at the jobsite provides an effective tool for implementing an accurate, thorough testing of the controls. Attempting to resolve the many issues involved spontaneously at the project site will frequently lead to error, inefficient use of time, and incomplete testing of the systems.

LANTNAVFACENGCOM utilizes specification Sections 15901, Space Temperature Control Systems and 15910, Direct Digital Controls, for most contracts, to require a series of submittals and field tests. The intent is to provide a comprehensive program for testing of the controls. The steps involved in this process are as follows:

Step 1 (Pre-field Test Plan Submittal)- Typically, the plan is formatted to provide a series of one line statements which sequentially describe how the controls are to be tested, what procedures are to be followed during testing, and give a description of what results are to be attained. Similar formatting is also required for the Performance Verification Test Plan. Testing which must be addressed by the Field Test Plan follows:

- Tubing and Wiring Integrity Tests (Section 15901 ONLY)- Test tubing system pneumatically at 1.5 times the design working pressure for 24 hours. Test wiring for continuity, ground faults, and open and short circuits.

- Systems Inspection- Observe the HVAC system in it's shutdown condition. Check dampers and valves for proper normal positions.

- Calibration Accuracy and Operation Inputs Test- Check for proper calibration and operation of each input instrument. For each sensor, record the reading at the sensor using traceable test equipment, and record the reading at the digital controller. Document each reading for the test report.

- Operation of Outputs Test- Check the operation of each output to verify correct operation. Command digital outputs on and off. Command analog outputs to minimum range, such as 4 mA, and maximum range, such as 20 mA, measure and record commanded and actual outputs values. Document each command and result for the test report.

- Actuator Range Adjustment Test- With the digital controller, apply a control signal to each actuator and verify that the actuator operates properly from it's normal position to full range of stroke position. Record actual spring ranges and normal positions for all modulating control valves and dampers. Include documentation in the test report.

- Digital Controller Startup and Memory Test (Section 15910 ONLY)- Demonstrate the programming is not lost after power failure, and digital controllers automatically resume proper control after a power failure.

- Surge Protection Test (Section 15910 ONLY)- Show that surge protection, meeting the requirements of the specifications, have been installed on incoming power to the digital controllers and on communications lines.

- Application Software Operation Test (15910 ONLY)- Test compliance of the application software for:

  a. Ability to communicate with the digital controllers, uploading and downloading of control programs.

  b. Text editing program: Demonstrate the ability to edit the control program off line.

  c. Reporting of alarm conditions: Cause alarm conditions for each alarm, and ensure that workstation receives alarms.

  d. Reporting trend and status reports: Demonstrate ability of software to receive and save trend and status reports.

Step 2 (Conduct Field Testing) - The contractor implements the procedures listed in the Field Test Plan. It is highly recommended that the plan be closely adhered to during testing. At the Government's option this portion of testing may be witnessed by a Government representative. However, this is normally done on a random basis, as the complete Field test process is quite lengthy. It should be emphasized that the contractor's certification of the test results (see step 5) is a very serious matter and will be regarded as such.

Step 3 (Field Test Report Submittal)- Provide a written report containing test documentation after the field tests are completed.

Step 4 (Performance Verification Test Plan Submittal)- The Performance Verification Test is performed to demonstrate that the control system maintains set points, control loops are tuned, and controllers are programmed for the correct sequence of operation. The test plan is required to address/furnish each of the following:

- Execution of Sequence of Operation

  ♦ Furnish the Government graphed trends, which show the sequence of operation is executed in the correct order. (Section 15910 ONLY)

  ♦ Demonstrate the HVAC system operates properly through the complete sequence of operation, for example seasonal, occupied/unoccupied, warm-up.

  ♦ Demonstrate proper control system response for abnormal conditions for which there is a specified response by simulating these conditions.

  ♦ Demonstrate hardware interlocks and safeties work.

- ♦ Demonstrate the control system performs the correct sequence of control after a loss of power.

- <u>Control Loop Stability and Accuracy (15910 ONLY)</u>

  - ♦ Furnish the Government graphed trends of control loops to demonstrate the control loop is stable and that set point is maintained.

Control loop trend data shall be instantaneous and the time between data points shall not be greater than one minute.

Step 5 (Certification of Test Readiness)- Before scheduling the Performance Verification Test, furnish the field test documentation and written certification to the Contracting Officer that the installed system has been calibrated, tested, and is ready for the Performance Verification Test prior to receiving written permission to proceed from the Government.

Step 6 (Implementation of the Performance Verification Test Plan) - In implementing the ACATS testing, the Contractor meets the Government Representative at the jobsite. The Contractor should be fully prepared to implement the test, having all necessary instrumentation at hand. Also, the controls Contractor's Representative in attendance should be familiar with the test plan. The Contractor then implements the test using the test plan as outlined. It is strongly encouraged that the test plan be strictly followed while conducting the testing. It provides a "road map" for keeping the testing on an organized path and minimizes the chance of inadvertently deleting any portion of the testing.

If any portion of the testing identifies deficiencies, all such deficiencies should be compiled on a punch list for correction and shall be fully addressed by the field report. Judgment must be applied in deciding whether the results of the ACATS are sufficient to allow final acceptance of the controls to be issued. Be resigned to the fact that deficiencies will be encountered. As a matter of policy, deficiencies should be treated as punch list items when possible. However, where it is determined that outstanding deficiencies would have an adverse impact on the comfort, safety, or operations of the facility in question, corrections should be affected immediately, and final approval of the controls should be deferred until corrections have been completed and the controls have been successfully re-tested. Controls which have initially been found deficient during testing should never be accepted after correction until they have been re-tested.

We wish to emphasize the importance of having a Government Representative in attendance full time during the ACATS testing. Every effort should be made to have representation by either Code 052 or the ROICC during testing. For those projects where Code 052 will not be in attendance due to other scheduling commitments, they should be witnessed by a Construction Representative, Mechanical Specialist. It is <u>unacceptable</u> to allow the testing to be conducted without Government representation.

Our past experiences have shown us that testing under these circumstances is far less effective and creates a high probability of problems showing up later on.

It is very commonplace during the implementation of ACATS to determine that changes in the controls installation have been made during installation and revisions have not been made to the automatic controls drawings to reflect these changes. It is recommended that the controls drawings be confirmed during the testing by a government representative and any changed conditions noted. Always require that accurate as-built controls drawings be provided when changes or deficiencies are identified. The ability to effectively maintain proper maintenance of these systems is greatly affected if poor as-built drawings are provided to facilities management personnel at turnover.

Step 7 (Submit Performance Verification Test Report)- Provide a written report containing test documentation after the field tests are completed.

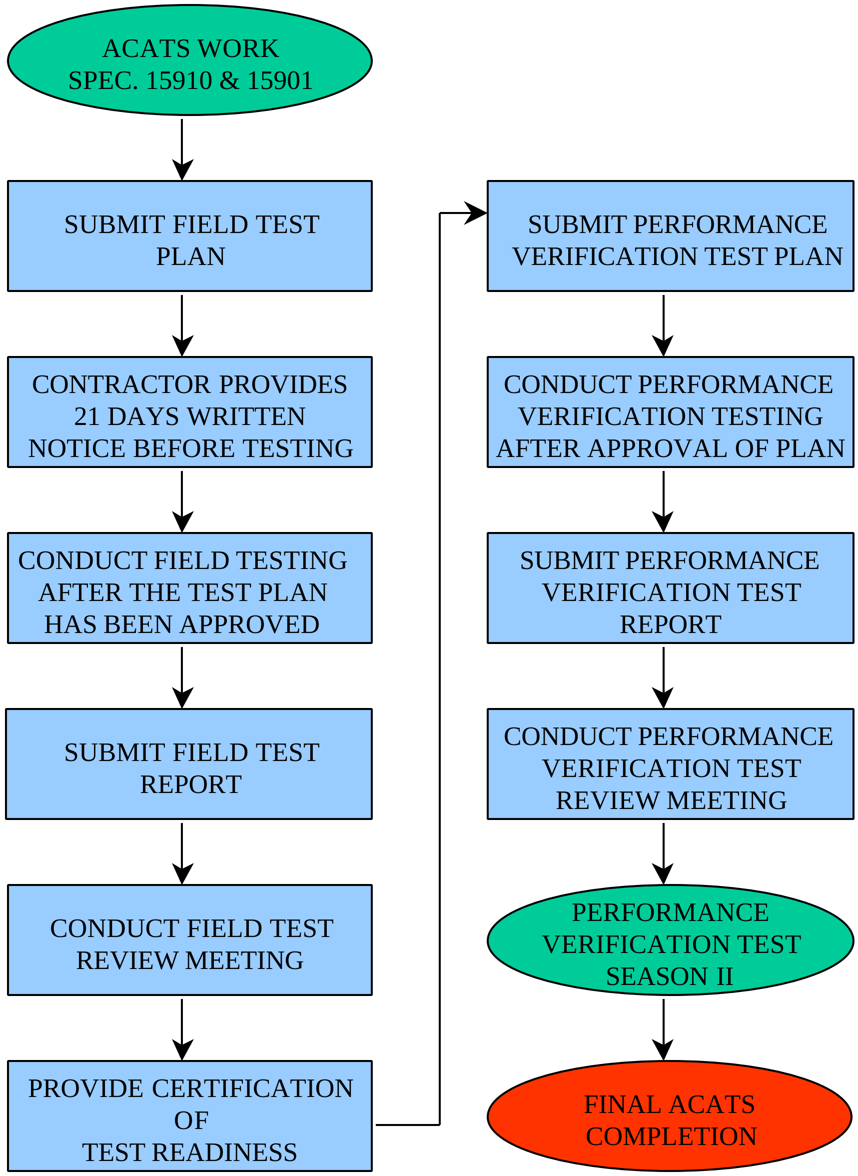
Step 8 (Performance Verification Test Review Meeting)- After submitting the Performance Verification Test Report convene a test review meeting at the job site to present the results to the Government. As part of this test review meeting, demonstrate by performing all portions of the field tests that each failure has been corrected. Based on the report and test review meeting, the Government will determine either the restart or successful completion of testing.

Step 9 (Perform Opposite Season Test)- Repeat the Performance Verification Test during an opposite season to the first test. Test procedures of the Performance Verification Test are to be used for the Opposite Season Test.

ACATS- SUMMARY OF THE OVERALL PROCESS

The information provided in this handbook is typical for nearly all projects. However, we highly recommend that you consult the specifications for the specific project in question when determining contractual requirements. There have been several generations of specifications used for ACATS, and it is commonplace to find variations in the contractual requirements. Always consult with the job specific specifications when administering the contract.

The following flow charts are used to provide a quick reference and summarize the overall ACATS process.



ACATS OVERALL PROCESS - SEASON I/II

Automatic Temperature Control System
Field Verification

PROJECT
NAS, OCEANA
AIR OPERATIONS CONTROL TOWER

SUBMITTED BY:
DAMUTH TRANE
1100 CAVALIER BLVD
CHESAPEAKE, VA 23323

PROCEDURES

3.2.4.1 – System Inspection (Sheets 1 and 2)

1) Observe the equipment in its shutdown condition.
2) Check dampers and valves for proper normal positions.
3) Document each position on System Inspection Test Sheet(s).

3.2.4.2 – Calibration Accuracy and Operation of Input Test (Sheets 3 and 4)

1) Record the measured reading taken with calibrated test equipment for each sensor listed on Test Sheet(s).
2) Record the reading provided by the Building Automation System for each sensor listed.
3) Record any offset input for calibration purposes for each sensor.

3.2.4.3 – Operation of Outputs Test (Sheets 5 – 7)

1) Command digital outputs Off and On. Record output voltage.
2) Command analog outputs to minimum and maximum values. Record output voltages.

3.2.4.4 – Actuator Range Adjustment Test (Sheets 8 and 9)

1) Command actuators to minimum and maximum positions. Record response of actuator to each command.
2) Document actuator normal position on test sheet.

3.2.4.5 – Digital Controller Startup and Memory Test (Sheet 10)

1) Power down each controller on test sheet.
2) Power up each controller.
3) Verify and document that program data is retained.

3.2.4.6 – Surge Protection Test (Sheet 10)

1) Document that approved surge protection is installed on incoming power to each controller.
2) Document that approved surge protection is installed on incoming phone communications line to BCU.

3.2.4.7 – Application Software Operation Test; Paragraphs (a) and (b), (Sheet 11)

1) Demonstrate the ability to communicate with the digital controllers.
2) Demonstrate the ability to upload and download programs to one or more controllers.
3) Demonstrate the ability to edit the control program in the BCU.

3.2.4.7 – Application Software Operation Test; Paragraph (c), (Sheets 12 and 13)

1) Demonstrate alarm reception at the workstation for each specified alarm condition.
2) Demonstrate communication failure alarms for each controller.
3) Demonstrate a sensor failure alarm for each analog sensor so specified.

3.2.4.7 – Application Software Operation Test; Paragraph (d), (Sheet 14)

1) Demonstrate the ability to trend an analog input value.
2) Demonstrate the ability to create a status report (trend) for a digital input condition.

SYSTEM INSPECTION - 3.2.4.1

EQUIPMENT	NORMAL POSITION	OBSERVED STATE	INITIALS/REMARKS
AHU-1:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
CHW COIL VALVE	COIL BYPASS		
HW COIL VALVE	COIL BYPASS		
AHU-2:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
F & B DAMPER	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		
HW COIL VALVE	COIL BYPASS		
HW SYSTEM:			
HWP-3	OFF		
HWP-4	OFF		
HWC-1 VALVE	CLOSED		
FC-1:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		
FC-2:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		
FC-3:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		

SYSTEM INSPECTION - 3.2.4.1

EQUIPMENT	NORMAL POSITION	OBSERVED STATE	INITIALS/REMARKS
FC-4:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		
FC-5:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		
FC-6:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		
EF-1	OFF		
FC-7:			
SUPPLY FAN	OFF		
O.A. DAMPER	CLOSED		
HW COIL VALVE	COIL BYPASS		
CHW COIL VALVE	COIL BYPASS		

CALIBRATION ACCURACY and OPERATION of INPUT - 3.2.4.2

	READINGS			
SENSOR	**MEASURED**	**SYSTEM**	**OFFSET**	**INITIALS/REMARKS**
AHU-1:				
INTAKE TEMP				
RETURN TEMP				
DISCHARGE TEMP				
SPACE TEMP				
AHU-2:				
INTAKE TEMP				
DISCHARGE TEMP				
CHW SYSTEM:				
CHW SUPPLY TEMP				
CHW RETURN TEMP				
HW SYSTEM:				
HW SUPPLY TEMP				
HW RETURN TEMP				
FC-1:				
DISCHARGE TEMP				
SPACE TEMP				
FC-2:				
DISCHARGE TEMP				
SPACE TEMP				
FC-3:				
DISCHARGE TEMP				
SPACE TEMP				
FC-4:				
DISCHARGE TEMP				
SPACE TEMP				

CALIBRATION ACCURACY and OPERATION of INPUT - 3.2.4.2

	READINGS			
SENSOR	MEASURED	SYSTEM	OFFSET	INITIALS/REMARKS
FC-5:				
DISCHARGE TEMP				
SPACE TEMP				
FC-6:				
DISCHARGE TEMP				
SPACE TEMP				
FC-7:				
DISCHARGE TEMP				
SPACE TEMP				

OPERATION OF OUTPUTS - 3.2.4.3

OUTPUT	COMMAND	MEASURED VOLT.	INITIALS/REMARKS
AHU1:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		
AHU2:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
OA DAMPER	CLOSE(0V)		
OA DAMPER	OPEN(24V)		
HW COIL VALVE	CLOSE(24V)		
HW COIL VALVE	OPEN(0V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
F & B DAMPER	100%(2V)		
F & B DAMPER	0%(10V)		
CHW SYSTEM:			
CHW PUMP P1	OFF(0V)		
CHW PUMP P1	ON(24V)		
CHW PUMP P2	OFF(0V)		
CHW PUMP P2	ON(24V)		
CHILLER ACC-1	OFF(0V)		
CHILLER ACC-1	ON(24V)		
CHILLER RESET	MIN(2V)		
CHILLER RESET	MAX(10V)		
HW SYSTEM:			
HW PUMP P3	OFF(0V)		
HW PUMP P3	ON(24V)		
HW PUMP P4	OFF(0V)		
HW PUMP P4	ON(24V)		
HWC-1 STM VALVE	0%(2V)		
HWC-1 STM VALVE	100%(10V)		

OPERATION OF OUTPUTS - 3.2.4.3

OUTPUT	**COMMAND**	**MEASURED VOLT.**	**INITIALS/REMARKS**
FC1:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		
FC2:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		
FC3:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		
FC4:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		

OPERATION OF OUTPUTS - 3.2.4.3

OUTPUT	**COMMAND**	**MEASURED VOLT.**	**INITIALS/REMARKS**
FC5:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		
FC6:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		
FC7:			
SUPPLY FAN	OFF(0V)		
SUPPLY FAN	ON(24V)		
CHW COIL VALVE	0%(2V)		
CHW COIL VALVE	100%(10V)		
HW COIL VALVE	0%(10V)		
HW COIL VALVE	100%(2V)		

ACTUATOR RANGE ADJUSTMENT - 3.2.4.4

OUTPUT	**COMMAND**	**RESPONSE**	**NOR. POS.**	**INITIALS/REMARKS**
AHU1:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			
AHU2:				
OA DAMPER	CLOSE			
OA DAMPER	OPEN			
HW COIL VALVE	CLOSE			
HW COIL VALVE	OPEN			
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
F & B DAMPER	0%			
F & B DAMPER	100%			
HW SYSTEM:				
HWC-1 STM VALVE	0%(2V)			
HWC-1 STM VALVE	100%(10V)			
FC1:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			
FC2:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			

ACTUATOR RANGE ADJUSTMENT - 3.2.4.4

OUTPUT	**COMMAND**	**RESPONSE**	**NOR. POS.**	**INITIALS/REMARKS**
FC3:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			
FC4:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			
FC5:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			
FC6:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			
FC7:				
CHW COIL VALVE	0%			
CHW COIL VALVE	100%			
HW COIL VALVE	0%			
HW COIL VALVE	100%			

DIGITAL CONTROLLER STARTUP AND MEMORY - 3.2.4.5
SURGE PROTECTION - 3.2.4.6

CONTROLLER	POWER DOWN	POWER UP	PROGRAM RETENTION	SURGE PROTECTION	NOTES
UPCM1					
UPCM2					
FC1_PCM1					
FC2_PCM2					
FC3_PCM3					
FC4_PCM4					
FC5_PCM5					
FC6_PCM6					
FC7_PCM7					
HW_PCM8					
BCU1					

APPLICATION SOFTWARE OPERATION - 3.2.4.7
A. COMMUNICATIONS; B. EDITING

		PROGRAM	PROGRAM	
CONTROLLER	COMMUNICATIONS	UPLOAD	DOWNLOAD	NOTES
UPCM1				
UPCM2				
FC1_PCM1				
FC2_PCM2				
FC3_PCM3				
FC4_PCM4				
FC5_PCM5				
FC6_PCM6				
FC7_PCM7				
HW_PCM8				
BCU1				
CONTROLLER	PROGRAM EDITING			NOTES
BCU1				

APPLICATION SOFTWARE OPERATION - 3.2.4.7
C. ALARM REPORTING

POINT	SPECIFIED ALARM	NORMAL CONDITION	ALARM CONDITION	SENSOR FAILURE	NOTES
UPCM1	COMM FAIL			N/A	
AHU2 DISCH TEMP	HIGH TEMP				
AHU2 AIRFLOW	FLOW FAIL			N/A	
AHU2 SUPPLY FAN	FAN FAIL			N/A	
AHU2 FILTER	DIRTY FILTER			N/A	
AHU2 FREEZESTAT	LOW LIMIT			N/A	
CHWS TEMP	HIGH TEMP				
CHWS TEMP	LOW TEMP				
CHWR TEMP	HIGH TEMP				
CHW FLOW	FLOW FAIL			N/A	
CHILLER	MALFUNCTION				
UPCM2	COMM FAIL			N/A	
AHU1 DISCH TEMP	HIGH TEMP				
AHU1 AIRFLOW	FLOW FAIL			N/A	
AHU1 SUPPLY FAN	FAN FAIL			N/A	
AHU1 FILTER	DIRTY FILTER			N/A	
AHU1 FREEZESTAT	LOW LIMIT			N/A	
AHU1 SMOKE DET	SMOKE			N/A	
HW-PCM8	COMM FAIL			N/A	
HW SUPPLY	LOW TEMP				
HWP P3	PUMP FAIL			N/A	
HWP P4	PUMP FAIL			N/A	
FC1-PCM1	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC1 AIRFLOW	FLOW FAIL			N/A	
FC1 SUPPLY FAN	FAN FAIL			N/A	
FC1 FILTER	DIRTY FILTER			N/A	
FC2-PCM2	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC2 AIRFLOW	FLOW FAIL			N/A	
FC2 SUPPLY FAN	FAN FAIL			N/A	
FC2 FILTER	DIRTY FILTER			N/A	

APPLICATION SOFTWARE OPERATION - 3.2.4.7
C. ALARM REPORTING

POINT	SPECIFIED ALARM	NORMAL CONDITION	ALARM CONDITION	SENSOR FAILURE	NOTES
FC3-PCM3	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC3 AIRFLOW	FLOW FAIL			N/A	
FC3 SUPPLY FAN	FAN FAIL			N/A	
FC3 FILTER	DIRTY FILTER			N/A	
FC4-PCM4	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC4 AIRFLOW	FLOW FAIL			N/A	
FC4 SUPPLY FAN	FAN FAIL			N/A	
FC4 FILTER	DIRTY FILTER			N/A	
FC5-PCM5	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC5 AIRFLOW	FLOW FAIL			N/A	
FC5 SUPPLY FAN	FAN FAIL			N/A	
FC5 FILTER	DIRTY FILTER			N/A	
FC6-PCM6	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC6 AIRFLOW	FLOW FAIL			N/A	
FC6 SUPPLY FAN	FAN FAIL			N/A	
FC6 FILTER	DIRTY FILTER			N/A	
FC7-PCM7	COMM FAIL			N/A	
DISCH TEMP	HIGH TEMP				
FC7 AIRFLOW	FLOW FAIL			N/A	
FC7 SUPPLY FAN	FAN FAIL			N/A	
FC7 FILTER	DIRTY FILTER			N/A	

APPLICATION SOFTWARE OPERATION - 3.2.4.7
D. TREND/STATUS REPORTS

	TREND	BEGINNING	ENDING	
POINT	REPORT	TIME	TIME	NOTES
ANALOG POINT				
	STATUS	BEGINNING	ENDING	
POINT	REPORT	TIME	TIME	NOTES
DIGITAL POINT				
END				

TAB F

ACATS EXAMPLE
TEST PLAN

LANTOPS CONSTRUCTION DIVISION
CODE 052 ENGINEERING SUPPORT BRANCH

"ENGINEERING SUPPORT TO THE FIELD"

AUTOMATIC CONTROLS ACCEPTANCE TESTS (ACATS) PERFORMANCE VERIFICATION TEST PLAN

CONTRACT N33 191-94-R-7003

MEGA I/QOL I

GYMNASIUM

CAPODICHINO

NAPLES, ITALY

Prepared by:
D.S. LARSEN, P.E.
Code 0521

20 February 1998

I. Air handling unit AHU-1

A. Test manual/auto modes of system

1. Position the H-O-A switch to the “off’ position.

- [ ] a. Verify the fan stops immediately.
- [ ] b. After 20 seconds, the outside and return air dampers close.
- [ ] c. Confirm that fan DPS/DDC fan off status.
- [ ] d. Confirm chilled wtr valve closed to coil.
- [ ] e. Confirm reheat valve open to coil.
- [ ] f. Check placement of return smoke detector.
- [ ] g. Check placement of supply smoke detector.
- [ ] h. Check placement of high limit static pressure sensor.
- [ ] i. Check placement of supply air temp sensor.
- [ ] j. Check placement of freezestat.
- [ ]]k. Check placement of filter DPS.
- [ ] l. Check placement of return air temp sensor.
- [ ] m. Check placement of return air humidity sensor.
- [ ] n. Check placement of room air temp sensor.
- [ ] o. Verify piping/valve configuration on hot and chilled water valves.

2. Position the H-O-A to “Auto” position. Have the DDC system initiate start.

- [ ] a. Confirm return air damper opens.
- [ ] c. Confirm a 10 second time delay starts after the return damper is fully open. After 10 seconds the fan starts.
- [ ] b. The outside air damper opens to preset min position.

- [ ] d. Verify room temp control loop is activated.
- [ ] e. Verify humidity control loop is activated.
- [ ] f. Confirm fan DPS/DDC fan on status.

3. With the H-O-A in the "Auto" position, have the DDC system initiate "off'.

- [ ] a. Verify the fan stops immediately.
- [ ] b. After 20 seconds, the outside and return air dampers close.
- [ ] c. Confirm the fan DPS/DDC fan off status.
- [ ] d. Confirm chilled wtr valve closed to coil.
- [ ] e. Confirm reheat valve open to coil.

4. Position the H-O-A to the "On" position.

- [ ]]a. Confirm return air damper opens.
- [ ] b. Confirm a 10 second time delay starts <u>after</u> the return damper is fully open. After 10 seconds the fan starts.
- [ ] c. The outside air damper opens to preset min position.
- [ ] d. Verify room temp control loop is activated.
- [ ] e. Verify humidity control loop is activated.
- [ ] f. Confirm fan DPS/DDC fan on status.

B. <u>Testing of Control Loops</u>

1. Test room temperature control loop.

- [ ] a. Raise the humidity control setpoint at the DDC to ensure no influence on the chilled water control valve position.
- [ ] b. Lower the room dry bulb temperature setpoint at the DDC to simulate a rise in room temperature.
- [ ] c. Verify the chilled water control valve modulates open to the coil.
- [ ] d. Verify the reheat water control valve modulates closed to the coil.

☐ e. Slowly raise the room dry bulb temperature setpoint at the DDC to simulate a drop in room temperature in increments.

☐ f. Verify that sequentially the chilled water valve closes to the coil and that once the chilled water valve is fully closed to the coil, the reheat control valve modulates open to the coil. Confirm no over-lap between the chilled/hot wtr coils.

☐ g. Return DDC setpoints to design values.

2. Test room humidity control loop.

☐ a. Raise the room temperature setpoint at the DDC to ensure no influence on the chilled water control valve position.

☐ b. Verify the reheat water control valve modulates open to the coil.

☐ c. Lower the room humidity setpoint at the DDC to simulate a rise in room humidity.

☐ d. Verify the chilled water control valve modulates open to the coil.

☐ e. Slowly raise the room humidity setpoint at the DDC to simulate a drop in room humidity in increments.

☐ f. Verify that sequentially the chilled water valve closes to the coil, while the reheat control valve remains open to the coil.

☐ g. Return DDC setpoints to design values.

C. Test Alarm/Monitoring Functions

1. Simulate smoke detector activation in accordance with manufacturers recommended test method (magnet, smoke generator, etc.). Make sure building occupants and Fire Dept are notified before proceeding. Call Fire Dept both before and after testing. Test both return air and supply air detector.

☐ a. Confirm that smoke detector actuation sends alarm to the fire alarm panel.

☐ b. Verify the fan stops immediately.

☐ c. After 20 seconds, the outside and return air dampers close.

2. Simulate a drop in chilled water coil entering air temperature by raising freezestat setpoint, or by spraying freezestat capillary tube element with electronic low temp spray, or by manually depressing freezestat manual reset button.

☐ a. Verify the fan stops immediately.

☐ b. After 20 seconds, the outside and return air dampers close.

3. Simulate a rise in duct static pressure by lowering the high static pressure control safety control setpoint.

☐ a. Verify the fan stops immediately.

☐ b. After 20 seconds, the outside and return air dampers close.

4. Confirm that the DDC initially provides a monitor status of the air filters as being "clean". Simulate a rise in filter differential pressure drop by lowering alarm setpoint value.

☐ a. Confirm that an alarm message is issued by the DDC.

D. Control Loop Trend Log Test Procedures

1. Initiate a trend log of the room temperature control loop. Allow the unit to operate for at least two hours to stabilize control loop operation.

☐ a. Trend room temperature, chilled water valve % open position, reheat valve % open position for a period of one hour. Compile trend variable readings every minute during the trend period.

☐ b. Print a graphed hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.

☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.

☐ d. Introduce a disturbance in the control loop by raising the room temperature setpoint from design 5^0F higher.

☐ e. Continue to trend the roomconditions. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.

☐ f. Print a graphed hard copy of the compiled trend data.

2. Initiate a trend log of the room humidity control loop. Allow the unit to operate for at least two hours to stabilize control loop operation.

☐ a. Trend room humidity, chilled water valve % open position, reheat valve % open position for a period of one hour. Compile trend variable readings every minute during the trend period.

☐ b, Print a graph hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.

☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.

☐ d. Introduce a disturbance in the control loop by lowering the room humidity setpoint from design to 5% lower.

☐ e. Continue to trend the room conditions. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.

☐ f. Print a graphed hard copy of the compiled trend data.

II. Air handling: unit AHU-2

A. Test manual/auto modes of system

1. Position the H-O-A switch to the "off' position.

- [ ] a. Verify the fan stops immediately.
- [ ] b. After 20 seconds, the outside air dampers close.
- [ ] c. Confirm that fan DPS/DDC fan off status.
- [ ] d. Confirm chilled wtr valve closed to coil.
- [ ] e. Confirm reheat valve open to coil.
- [ ] f. Confirm preheat valve open to coil.
- [ ] g. Check placement of supply smoke detector.
- [ ] h. Check placement of supply air temp sensor.
- [ ] j. Check placement of freezestat.
- [ ] k. Check placement of filter DPS.
- [ ] l. Check placement of preheat leaving air temp sensor.
- [ ] m. Check placement of room humidity sensor.
- [ ] n. Check placement of room air temp sensor.
- [ ] o. Verify piping/valve configuration on hot and chilled water valves.
- [ ] p. Verify that when the supply fan is de-energized, exhaust fans EF-2, 3 and 4 are de-energized.

2. Position the H-O-A to "Auto" position. Have the DDC system initiate start.

- [ ] a. Confirm outside air damper opens.
- [ ] c. Confirm a damper end switch closes when the damper is fully open. The fan then starts <u>only</u> after the end switch has closed.
- [ ] d. Verify room temp control loop is activated.

- [ ] e. Verify humidity control loop is activated.
- [ ] f. Verify the preheat control loop is activated.
- [ ] g. Confirm fan DPS/DDC fan on status.
- [ ] h. Verify that when the supply fan is energized, exhaust fans EF-2, 3 and 4 are energized.

3. With the H-O-A in the "Auto" position, have the DDC system initiate "off ".

- [ ] a. Verify the fan stops immediately.
- [ ] b. After 20 seconds, the outside air damper closes.
- [ ] c. Confirm the fan DPS/DDC fan off status.
- [ ] d. Confirm chilled wtr valve closed to coil.
- [ ] e. Confirm reheat valve open to coil.
- [ ] f. Confirm preheat valve open to coil.
- [ ] g. Verify that when the supply fan is de-energized, exhaust fans EF-2, 3 and 4 are de-energized.

4. Position the H-O-A to the "On" position.

- [ ] a. Confirm outside air damper opens.
- [ ] b. Confirm a damper end switch closes when the damper is fully open. The fan then starts <u>only</u> after the end switch has closed.
- [ ] c. Verify room temp control loop is activated.
- [ ] d. Verify humidity control loop is activated.
- [ ] e. Verify the preheat control loop is activated.
- [ ] f. Confirm fan DPS/DDC fan on status.
- [ ] g. Verify that when the supply fan is energized, exhaust fans EF-2,3 and 4 are energized.

B. Testing of Control Loops

1. Test room temperature control loop.

- [ ] a. Raise the humidity control setpoint at the DDC to ensure no influence on the chilled water control valve position.

- [ ] b. Lower the room dry bulb temperature setpoint at the DDC to simulate a rise in room temperature.

- [ ] c. Verify the chilled water control valve modulates open to the coil.

- [ ] d. Verify the reheat water control valve modulates closed to the coil.

- [ ] e. Slowly raise the room dry bulb temperature setpoint at the DDC to simulate a drop in room temperature in increments.

- [ ] f. Verify that sequentially the chilled water valve closes to the coil and that once the chilled water valve is fully closed to the coil, the reheat control valve modulates open to the coil. Confirm no over-lan between the chilled/hot wtr coils.

- [ ] g. Return DDC setpoints to design values.

2. Test room humidity control loop.

- [ ] a. Raise the room temperature setpoint at the DDC to ensure no influence on the chilled water control valve position.

- [ ] b. Verify the reheat water control valve modulates open to the coil.

- [ ] c. Lower the room humidity setpoint at the DDC to simulate a rise in room humidity.

- [ ] d. Verify the chilled water control valve modulates open to the coil.

- [ ] e. Slowly raise the room humidity setpoint at the DDC to simulate a drop in room humidity in increments.

- [ ] f. Verify that sequentially the chilled water valve closes to the coil, while the reheat control valve remains open to the coil.

- [ ] g. Return DDC setpoints to design values.

3. Test Preheat Coil air temperature control loop,

☐]a. Raise the leaving air temperature setpoint at the DDC to simulate drop in air temperature.

☐ b. Verify the Preheat water control valve modulates open to the coil.

☐c. Lower the leaving air temperature setpoint at the DDC to simulate a rise in air temperature.

☐d. Verify the Preheat water control valve modulates closed to the coil.

☐e. Return DDC setpoints to design values.

4. Test room humidity sensor discrimination.

☐a. Raise the temperature control setpoint at the DDC to ensure no influence on the chilled water control valve position,

☐ b. Offset the room humidity sensor to simulate a rise in women's locker room G-24 humidity.

☐c. Offset the room humidity sensor to simulate a drop in men's locker room G-32 humidity.

☐d. Verify the chilled water control valve opens to the coil.

☐ e. Offset the room humidity sensor to simulate a drop in women's locker room G-24 humidity.

☐f. Verify the chilled water control valve closes to the coil.

☐g. Offset the room humidity sensor to simulate a rise in men's locker room G-32 humidity.

☐h. Verify the chilled water control valve opens to the coil.

☐ i. Remove sensor offsets in both rooms G-24 and G-32.

C. Test Alarm/Monitoring Functions

1. Simulate supply duct smoke detector activation in accordance with manufacturers recommended test method (magnet, smoke generator, etc.). Make sure building occupants and Fire Dept are notified before proceeding. Call Fire Dept both before and after testing.

☐ a. Confirm that smoke detector actuation sends alarm to the fire alarm panel.

☐ b. Verify the fan stops immediately.

☐ c. After 20 seconds, the outside air damper closes.

2. Simulate a drop in chilled water coil entering air temperature by raising freezestat setpoint, or by spraying freezestat capillary tube element with electronic low temp spray, or by manually depressing freezestat manual reset button.

☐ a. Verify the fan stops immediately.

☐ b. After 20 seconds, the outside air dampers close.

3. Confirm that the DDC initially provides a monitor status of the air filters as being "clean". Simulate a rise in filter differential pressure drop by lowering alarm setpoint value.

☐ a. Confirm that an alarm message is issued by the DDC.

D. Control Loop Trend Log Test Procedures

1. Initiate a trend log of the room temperature control loop. Allow the unit to operate for at least two hours to stabilize control loop operation.

☐ a. Trend room temperature, chilled water valve % open position, reheat valve % open position for a period of one hour. Compile trend variable readings every minute during the trend period.

☐ b. Print a graphed hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.

☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.

☐ d. Introduce a disturbance in the control loop by raising the room temperature setpoint from design 5^0F higher.

☐ e. Continue to trend the room conditions. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.

☐ f. Print a graphed hard copy of the compiled trend data.

2. Initiate a trend log of the room humidity control loop. Allow the unit to operate for at least two hours to stabilize control loop operation.

- ☐ a. Trend room humidity, chilled water valve % open position, reheat valve % open position for a period of one hour. Compile trend variable readings every minute during the trend period.
- ☐ b. Print a graph hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.
- ☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.
- ☐ d. Introduce a disturbance in the control loop by lowering the room humidity setpoint from design to 5% lower.
- ☐ e. Continue to trend the room conditions. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.
- ☐ f. Print a graphed hard copy of the compiled trend data.

3. Initiate a trend log of the pre-heat coil control loop.

- ☐ a. Trend pre-heat coil leaving air temperature, preheat valve % open position for a period of one hour. Compile trend variable readings every minute during the trend period.
- ☐ b. Print a graphed hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.
- ☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.
- ☐ d. Introduce a disturbance in the control loop by raising leaving air temperature setpoint from design 5^0F higher.
- ☐ e. Continue to trend the leaving air conditions. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.
- ☐ f. Print a graphed hard copy of the compiled trend data.

III. Air handling unit AHU-3

A. Test manual/auto modes of system

1. Position the H-O-A switch to the “off’ position.

- ☐ a. Verify the fan stops immediately.
- ☐]b. After 20 seconds, the outside and return air dampers close.
- ☐ c. Confirm that fan DPS/DDC fan off status.
- ☐ d. Confirm chilled wtr valve closed to coil.
- ☐ e. Check placement of return smoke detector.
- ☐ f. Check placement of supply smoke detector.
- ☐ g. Check placement of hi limit static pressure sensor.
- ☐ h. Check placement of mixed air static pressure sensor.
- ☐ i. Check placement of downstream duct static pressure sensor.
- ☐ j. Check placement of supply air temp sensor.
- ☐ k. Check placement of freezestat.
- ☐ l. Check placement of filter DPS.
- ☐ m. Check placement of return air duct temp sensor.
- ☐ n. Check placement of return air duct humidity sensor.
- ☐ o. Verify piping/valve configuration on chilled water valve.
- ☐ p. Verify that when the supply fan is de-energized, exhaust fans EF-5 and 7 are de-energized.

2. Position the H-O-A to “Auto” position. Have the DDC system initiate start.

- ☐ a. Confirm return air damper opens.
- ☐ c. Confirm a 10 second time delay starts <u>after</u> the return damper is fully open. After 10 seconds the fan starts.

- [ ]]b. Confirm the outside air damper opens to preset min position.
- [ ] d. Verify supply air temp control loop is activated.
- [ ] e. Verify downstream static pressure control loop is activated.
- [ ] f. Verify outsidereturn air static pressure control loop is activated.
- [ ] g. Confirm fan DPS/DDC fan on status.
- [ ] h. Verify that when the supply fan is energized, exhaust fans EF-5 and 7 are energized.

3. With the H-O-A in the "Auto" position, have the DDC system initiate "off '.

- [ ]]a. Verify the fan stops immediately.
- [ ] b. After 20 seconds, the outside and return air dampers close.
- [ ] c. Confirm the fan DPS/DDC fan off status.
- [ ] d. Confirm chilled wtr valve closed to coil.
- [ ] e. Verify that when the supply fan is de-energized, exhaust fans EF-5 and 7 are de-energized.

4. Position the H-O-A to the "On" position.

- [ ] a. Confirm return air damper opens.
- [ ] b. Confirm a 10 second time delay starts after the return damper is fully open. After 10 seconds the fan starts.
- [ ] c. Confirm the outside air damper opens to preset min position.
- [ ] d. Verify supply air temp control loop is activated.
- [ ] e. Verify downstream static pressure control loop is activated.
- [ ] f. Verify return air static pressure control loop is activated.
- [ ] g. Confirm fan DPS/DDC fan on status.

☐ h. Verify that when the supply fan is energized, exhaust fans EF-5 and 7 are energized.

B. Testing; of Control Loops

1. Test supply air temperature control loop.

☐ a. Lower the supply air temperature setpoint at the DDC to simulate a rise in temperature.

☐ b. Verify the chilled water control valve modulates open to the coil.

☐ c. Slowly raise the supply air temperature setpoint at the DDC to simulate a drop in temperature.

☐ d. Verify that the chilled water valve closes to the coil.

☐ e. Return DDC setpoints to design values.

2. Test downstream static pressure control loop.

☐ a. Raise the downstream static pressure setpoint at the DDC to simulate a drop in duct static pressure.

☐]b. Verify the variable frequency drive frequency output increases and the duct downstream static pressure increases.

☐ c. Lower the duct downstream static pressure setpoint to simulate a rise in duct downstream static pressure.

☐ d. Verify the variable frequency drive frequency output decreases and the duct downstream static pressure decreases.

☐ e. Return DDC setpoints to design values.

3. Test Mixed air static pressure control loop.

☐ a. Raise the mixed air differential static pressure control loop setpoint at the DDC to simulate a drop in outside air flow.

☐ b. Verify the outside air dampers remain fixed and the return air dampers close proportionately to increase outside air flow.

☐ c. Lower the mixed air differential static pressure control loop setpoint at the DDC to simulate a rise in outside air flow.

☐d. Verify the outside air dampers remain fixed and the return air dampers open proportionately to decrease outside air flow.

☐]e. Return DDC setpoints to design values.

C. Test Alarm/Monitoring Functions

1. Simulate supply and return duct smoke detector activation in accordance with manufacturers recommended test method (magnet, smoke generator, etc.). Make sure building occupants and Fire Dept are notified before proceeding. Call Fire Dent both before and after testing.

☐]a. Confirm that smoke detector actuation sends alarm to the fire alarm panel.

☐b. Verify the fan stops immediately.

☐c. After 20 seconds, the outside and return air dampers close.

2. Simulate a drop in chilled water coil entering air temperature by raising freezestat setpoint, or-by spraying freezestat capillary tube element with electronic low temp spray, or by manually depressing freezestat manual reset button.

☐a. Verify the fan stops immediately.

☐ b. After 20 seconds, the outside and return air dampers close.

3. Simulate a rise in duct static pressure by lowering the high static pressure control safety control setpoint.

☐a. Verify the fan stops immediately.

☐ b. After 20 seconds, the outside and return air dampers close.

4. Confirm that the DDC initially provides a monitor status of the air filters as being "clean". Simulate a rise in filter differential pressure drop by lowering alarm setpoint value.

☐ a. Confirm that an alarm message is issued by the DDC.

D. Control Loop Trend Log Test Procedures

1. Initiate a trend log of the supply air temperature control loop. Allow the unit to operate for at least two hours to stabilize control loop operation.

☐ a. Trend supply air temperature, chilled water valve % open position for a period of one hour. Compile trend variable readings every minute during the trend period.

☐]b. Print a graphed hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.

☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.

☐ d. Introduce a disturbance in the control loop by raising the supply air temperature setpoint from design 5^0F higher.

☐ e. Continue to trend the supply conditions. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.

☐ f. Print a graphed hard copy of the compiled trend data.

2. Initiate a trend log of the duct downstream static pressure control loop

☐ a. Trend downstream duct static pressure, VFD output frequency for a period of one hour. Compile trend variable readings every minute during the trend period.

☐ b. Print a graph hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.

☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.

☐ d. Introduce a disturbance in the control loop by lowering the duct downstream static pressure setpoint from design to .25 inches/62Pa lower.

☐ e. Continue to trend the static pressure. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.

☐ f. Print a graphed hard copy of the compiled trend data.

3. Initiate a trend log of the outside air static pressure control loop.

☐ a. Trend the outside air differential static pressure, outside air damper % open position, return damper % open position for a period of one hour. Compile trend variable readings every minute during the trend period.

☐ b. Print a graphed hard copy of the compiled trend data and examine it for any indications of hunting, control instability, excessive offset from controlled variable setpoint.

☐ c. Readjust control loop gain values if necessary and repeat test if adjustments are made. Print a graphed hard copy of the final compiled trend data.

☐]d. Introduce a disturbance in the control loop by raising mixed air static pressure control differential pressure from design . 10 inches/25 Pa higher.

☐]e. Continue to trend the static pressure. Confirm that the control loop control point converges to the new setpoint without hunting or loop instability.

☐ f. Print a graphed hard copy of the compiled trend data.

IV. Air handling unit AHU-4

A. Test manual/auto modes of system

1. Position the H-O-A switch to the “off’ position.

- [ ]]a. The Environmental Control Panel is de-energized.
- [ ] b. Verify the fan stops immediately.
- [ ] c. Verify the outside air damper closes.
- [ ] d. Confirm DX coil and compressors are de-energized.
- [ ] e. Confirm hot gas reheat valve closed to coil and face and by-pass has been installed.
- [ ] f. Confirm auxiliary hot water coil valve is closed to coil.
- [ ] g. Check placement of return smoke detector.
- [ ] h. Check placement of supply smoke detector.
- [ ] i. Check placement of refrigerant reheat coil, hot water reheat coil, DX coil.
- [ ] j. Check placement of filter DPS for return and outside air.
- [ ] k. Check placement of room air temp sensor.
- [ ] l. Check placement of room air humidity sensor.
- [ ] m. Verify piping/valve configuration on hot water valves.
- [ ] n. Verify piping and coil configuration for DX coil.
- [ ] o. Verify that when the supply fan is de-energized, exhaust fan EF-8 is de-energized.

2. Position the H-O-A to “Auto” position. Have the DDC system initiate start.

- [ ] a. Confirm that unit control panel is energized.
- [ ] b. Confirm outside air damper opens.

- [ ] c. The outside air damper opens to preset min position.

- [ ]]d. Confirm the fan starts.

- [ ] e. Verify room temp control loop is activated.

- [ ] f. Verify humidity control loop is activated.

- [ ] g. Verify Spa water temperature control loop is activated.

- [ ] h. Verify Pool Heating Water control loop is activated.

- [ ] i. Raise the outside air damper minimum position setting by the unit control panel and confirm that the damper positions toward the full open position.

- [ ] j. Verify that when the supply fan is energized, exhaust fan EF-8 is energized.

3. With the H-O-A in the "Auto" position, have the DDC system initiate "off'.

- [ ] a. The Environmental Control Panel is de-energized.

- [ ] b. Verify the fan stops immediately.

- [ ] c. Verify the outside air damper closes.

- [ ]]d. Confirm DX coil and compressors are de-energized.

- [ ] e. Confirm hot gas reheat valve closed to coil and face and by-pass has been installed.

- [ ] f. Confirm auxiliary hot water coil valve is closed to coil.

- [ ] g. Verify that when the supply fan is de-energized, exhaust fan EF-8 is de-energized.

4. Position the H-O-A to the "On" position.

- [ ] a. Confirm that unit control panel is energized.

- [ ] b. Confirm outside air damper opens.

- [ ] c. The outside air damper opens to preset min position.

- [ ] d. Confirm the fan starts.

- [ ] e. Verify room temp control loop is activated.

☐ f. Verify humidity control loop is activated.

☐ g. Verify Spa water temperature control loop is activated.

☐ h. Verify Pool Heating Water control loop is activated.

☐ i. Verify that when the supply fan is energized, exhaust fan EF-8 is energized.

B. Testing of Control Loops

1. Test room heating temperature control loop.

☐ a. Raise the room dry bulb temperature setpoint at the unit control panel to simulate a drop in room temperature.

☐ b. Verify the 3/w diverting valve on the compressor hot gas circuit diverts refrigerant hot gas from the auxiliary air cooled condenser to the hot gas reheat coil and the face damper begins to open.

☐ c. Raise the room dry bulb temperature setpoint at the unit control panel to simulate a further drop in space temperature.

☐ d. Verify that the auxiliary hot water reheat coil 3/w valve opens to the coil and the hot gas coil face damper is fully open.

☐ e. Lower the room dry bulb temperature setpoint at the unit control panel to simulate a rise in room temperature.

☐ f. Verify that the auxiliary hot water reheat coil 3/w valve closes to the coil.

☐ g. Lower the room dry bulb temperature setpoint at the unit control panel to simulate a further rise in space temperature.

☐ h. Verify the 3/w diverting valve on the compressor hot gas circuit diverts refrigerant hot gas to the auxiliary air cooled condenser in lieu of the hot gas reheat coil and the face damper is fully closed.

☐ i. Return DDC setpoints to design values.

2. Test room humidity control loop.

☐ a. Raise the room temperature setpoint at the unit control panel to ensure no cooling demand influence on the DX cooling.

☐ b. Verify the reheat water control valve modulates open to the coil, and the hot gas reheat is activated.

☐ c. Slowly lower the room humidity setpoint at the unit control panel to simulate a rise in room humidity.

☐ d. Verify the first stage of compressor capacity is energized and the lower coil section solenoid valve is open while the upper coil section solenoid valve closed.

☐ e. Slowly lower the room humidity setpoint further at the unit control panel to simulate a further rise in room humidity in increments.

☐ f. Verify that both stages of compressor capacity are activated and both DX coil solenoid valves are open, while the reheat control valve remains open to the coil.

☐ g. Slowly raise the room humidity setpoint at the unit control panel to simulate a drop in room humidity.

☐ h. Verify the first stage of compressor capacity is energized and the lower coil section solenoid valve is open while the upper coil section solenoid valve closed.

☐ i. Lower the room cooling setpoint at the unit control panel to simulate a call for cooling.

☐ j. Verify that both coil sections solenoid valves open.

☐ k. Raise the room cooling setpoint at the unit control panel to simulate the cooling space load is satisfied.

☐ l. Verify that upper coil section solenoid valve closes.

☐ m. Return unit control panel setpoints to design values.

3. Test room cooling temperature control loop.

☐ a. Lower the room dry bulb temperature setpoint at the unit control panel to simulate a rise in room temperature.

☐ b. Verify the first stage of compressor capacity control is energized.

☐ c. Lower the room dry bulb temperature setpoint at the unit control panel to simulate a further rise in space temperature.

☐ d. Verify that the second stage of compressor capacity control is energized.

☐ e. Raise the room dry bulb temperature setpoint at the unit control panel to simulate a drop in room temperature.

☐ f. Verify that the second stage of compressor capacity control is de-energized.

☐ g. Raise the room dry bulb temperature setpoint at the unit control panel to simulate a further drop in space temperature.

☐ h. Verify the first stage of compressor capacity control is de-energized.

☐ i. Return DDC setpoints to design values.

4. Test Pool Water Heating Control Loop.

☐ a. Raise the aquastat setpoint to simulate a drop in pool water temperature.

☐ b. Verify that, if the Pool Water Flow Switch is made, the pool water refrigerant diverting valve is de-energized, sending hot gas from the auxiliary air cooled heat rejection condenser to the Pool Heat Exchanger.

☐ c. Raise the aquastat setpoint further to simulate a continued drop in pool water temperature.

☐ d. Verify that with a continued drop in pool water temperature, the pool gas fired heater is energized.

☐ e. Lower the aquastat setpoint to simulate a rise in pool water temperature.

☐ f. Verify that with a rise in pool water temperature, the pool gas fired heater is de-energized.

☐ g. Lower the aquastat setpoint further to simulate a continued rise in pool water temperature.

☐ h. Verify that the pool water refrigerant diverting valve is energized, sending hot gas to the auxiliary air cooled heat rejection condenser in lieu of the Pool Heat Exchanger.

C. <u>Test Alarm/Monitoring Functions</u>

1. Simulate smoke detector activation in accordance with manufacturers recommended test method (magnet, smoke generator, etc.). <u>Make sure building occupants and Fire Dept are notified before proceeding. Call Fire Dept both before and after testing. Test both return air and supply air detector.</u>

☐ a. Confirm that smoke detector actuation sends alarm to the fire alarm panel.

- [ ] b. Verify the fan stops immediately.

- [ ] c. The outside air dampers close.

2. For both the outside air and return air filter cabinets confirm that the DDC initially provides a monitor status of the air filters being "clean". Simulate a rise in filter differential pressure drop by lowering alarm setpoint value.

- [ ] a. Confirm that an alarm message is issued by the DDC.

3. Verify placement and function of Remote Control Panel.

- [ ] a. Verify that the panel has a functional system switch.

- [ ] b. Verify that the panel has a functional fan switch.

- [ ] c. Verify that the panel has six(6) status lights.

4. Verify placement and function of Setback Monitoring Panel.

- [ ] a. Verify that the panel has a functional system switch.

- [ ] b. Verify that the panel has a functional fan switch.

- [ ] c. Verify that the panel has six(6) status lights.

- [ ] d. Verify 24 hr battery backup.

- [ ] e. Verify manual over-ride.

- [ ] f. Verify remote outside air potentiometer.

5. Verify placement and function of sensors.

- [ ] a. Verify room temperature sensor monitoring function at the DDC.

- [ ] b. Verify room humidity sensor monitoring function at the DDC.

6. Verify Trouble Alarm Interface between the Environmental Unit Control Panel.

- [ ] a. Verify that an alarm condition at the Unit Control Panel will initiate an alarm status at the DDC.

V. Chilled Water Svstem

A. Test manual/auto modes of system

1. Position the H-O-A switch to the "off' position.

- [ ] a. Confirm the present DDC designated lead chilled water pump is de-energized.
- [ ] b. Verify the chiller microprocessor controller is de-activated.
- [ ] c. Verify the chiller is de-energized.
- [ ] d. Confirm placement of chilled water flow meter and differential pressure transmitter.
- [ ] e. Confirm placement of chilled water supply and return temperature sensors.

2. Position the H-O-A switch to the "on" position.

- [ ] a. Confirm the present DDC designated lead chilled water pump is energized.
- [ ] b. Once the pump energizes, confirm that pump differential pressure switch initiates a DDC pump on status, and the chiller microprocessor control panel energizes.
- [ ] c. Verify the chiller is energized.

3. Position the H-O-A to "Auto" position. Have the DDC system initiate stop.

- [ ] a. Confirm the present DDC designated lead chilled water pump is de-energized.
- [ ]]b. Once the pump de-energizes, confirm that pump differential pressure switch initiates a DDC pump off status, and the chiller microprocessor control panel de-energizes.
- [ ] c. Confirm that the chilled is then de-energized.

4. With the H-O-A in "Auto" position, have the DDC system initiate start.

- [ ] a. Confirm the present DDC designated lead chilled water pump is energized.

☐ b. Once the pump energizes, confirm that pump differential pressure switch initiates a DDC pump on status, and the chiller microprocessor control panel energizes.

☐ c. Confirm that the chilled is then energized.

5. With the H-O-A in "Auto" position, have the DDC initiate stop. Then re-initiate start thru the DDC.

☐ a. Confirm the DDC alternates the lag chilled water pump with the lead pump, such that the prior lag pump is started on re-start.

6. Simulate a loss of operation at the lead chilled water pump by valving off the pump differential pressure switch pressure taps.

☐ a. Verify that the DDC monitors a loss of pump flow. After a 30 second time delay time out duration, the DDC starts the lag pump and de-activates the lead pump.

7. Verify that once the chiller microprocessor controller is activated, the chillers local control panel maintains capacity control of the chiller and maintains the desired supply chilled water temperature.

☐ a. Verify that the microprocessor controller is activated.

☐ b. Verify that the chilled water supply temperature is maintained at setpoint.

8. Simulate a loss of power to the chiller control circuit.

☐ a. Once the chiller is off, re-establish power to the chiller.

☐ b. Verify that the previous lead chiller designation remains in place by the DDC.

☐ c. Verify that the chiller starts with the normal designated automatic start mode.

B. Chiller Trend Logs

1. Trend the outside air temperature for 2 hours.

☐ a. Confirm that the DDC posted temperatures readings track with actual measured outside ambient temperature.

☐ b. Print a graphed hard copy of the trend results.

2. Trend System capacity for 2 hours.

☐ a. Trend system capacity in kW. Also trend on the same graph, flow, chilled water entering and leaving water temperature and set point.

☐ b. Print a graphed hard copy of the trend results.

☐ c. Ensure that the trended chilled water supply temperature meets design intended conditions and the control loop is stabile on the chiller microprocessor control panel.

<u>C. Chiller Alarms/Monitoring</u>

1. Run time maintenance.

☐ a. Verify that the DDC maintains runtime totals for the chiller and each pump.

2. Historical Log of Alarms.

☐]a. Verify that the DDC maintains a historical log of all alarms.

VI. Hot Water Heating System

1. Position the H-O-A switch to the “off’ position.

☐ a. Confirm the present DDC designated lead hot water pump is de-energized.

☐ b. Verify the boiler local controls are de-activated.

☐ c. Verify the boiler is de-energized.

☐ d. Confirm placement of hot water flow meter and differential pressure transmitter.

☐ e. Confirm placement of hot water supply and return temperature sensors.

2. Position the H-O-A switch to the “on” position.

☐ a. Confirm the present DDC designated lead hot water pump is energized.

☐ b. Once the pump energizes, confirm that pump differential pressure switch initiates a DDC pump on status, and the boiler control panel energizes.

☐ c. Verify the boiler is energized.

3. Position the H-O-A to “Auto” position. Have the DDC system initiate stop.

☐ a. Confirm the present DDC designated lead hot water pump is de-energized.

☐ b. Once the pump de-energizes, confirm that pump differential pressure switch initiates a DDC pump off status, and the boiler control panel de-energizes.

☐ c. Confirm that the boiler is then de-energized.

4. With the H-O-A in “Auto” position, have the DDC system initiate start.

☐ a. Confirm the present DDC designated lead hot water pump is energized.

☐ b. Once the pump energizes, confirm that pump differential pressure switch initiates a DDC pump on status, and the boiler control panel energizes.

☐ c. Confirm that the boiler is then energized.

5. With the H-O-A in “Auto” position, have the DDC initiate stop. Then re-initiate start thru the DDC.

☐ a. Confirm the DDC alternates the lag hot water pump with the lead pump, such that the prior lag pump is started on re-start.

6. Simulate a loss of operation at the lead hot water pump by valving off the pump differential pressure switch pressure taps.

☐ a. Verify that the DDC monitors a loss of pump flow. After a 30 second time delay time out duration, the DDC starts the lag pump and de-activates the lead pump.

7. Verify that once the boiler is activated, the boiler local control panel maintains the desired supply hot water temperature.

☐ a. Verify that the boiler controls are activated.

☐ b. Verify that the hot water supply temperature is maintained at setpoint.

☐ c. Simulate a drop in outside air temperature by offset at the DDC.

☐ d. Verify that the boiler hot water supply setpoint is raised to correspond to the specified schedule.

8. Simulate a loss of power to the boiler control circuit.

☐ a. Once the boiler is off, re-establish power to the boiler.

☐ b. Verify that the previous lead hot water pump designation remains in place by the DDC.

☐ c. Verify that the boiler starts with the normal designated automatic start mode.

B. Boiler Trend Logs

1. Trend the outside air temperature for 2 hours.

☐ a. Confirm that the DDC posted temperatures readings track with actual measured outside ambient temperature.

☐ b. Print a graphed hard copy of the trend results.

2. Trend System capacity for 2 hours.

☐ a. Trend system capacity in kW. Also trend on the same graph, flow, hot water entering and leaving water temperature and set point.

☐ b. Print a graphed hard copy of the trend results.

☐ c. Ensure that the trended hot water supply temperature meets design intended conditions and the control loop is stabile on the boiler control panel.

VII. Exhaust Fan Systems (EF-1 thru 9) and Supply Fans (SAF-1-3)

1. Position the H-O-A switch to the "off' position.

☐ a. Verify the fan stops immediately.

2. Position the H-O-A to "Auto" position. Have the DDC system initiate start.

☐]a- The fan starts.

3. With the H-O-A in the "Auto" position, have the DDC system initiate "off'.

☐ a. Verify the fan stops immediately.

4. Position the H-O-A to the "On" position.

☐ a. The fan starts.

5. For Exhaust Fans EF-1,6 and 9 and Supply Air Fans l-3 Thermostatic control.

☐ a. Lower the setpoint on the thermostat.

☐ b. Confirm that the fan starts.

☐ c. Raise the setpoint on the thermostat.

☐ d. Confirm that the fan is de-energized.

Fan Mark	Testing Completed	Remarks
EF-1		
EF-2		
EF-3		
EF-4		
EF-5		
EF-6		
EF-7		
EF-8		
EF-9		
SAF-1		
SAF-2		
SAF-3		

VIII. Variable Air Volume Terminal, Boxes

A. Occupied Mode Controls Tests

1. Test Space Temperature Control Modes

☐a. From an initial cold room temperature condition, verify that the hot water control valve is fully open, the fan energized, and the primary air damper positioned to maintain minimum specified primary airflow.

☐ b. Simulate a rise in room temperature by slowly lowering the room thermostat setpoint.

☐c. Verify that the hot water valve begins to move from the full open position toward the closed position. While the primary air damper remains positioned to maintain minimum primary airflow. Confirm the fan remains running at all times.

☐d. Simulate a continued rise in room temperature by slowly lowering the room thermostat setpoint.

☐]e. Verify that the hot water control valve positions fully closed, and the primary air damper just begins to move further open.

☐f. Simulate a continued rise in room temperature by lowering the room thermostat setpoint further.

☐g. Verify that the primary air damper opens further to maintain maximum primary airflow. Confirm that the airflow sensor AP reading is stabile with no indication of unusual hunting or turbulence.

☐h. From an initial hot room temperature condition, verify that the hot water control valve is fully closed, the fan energized, and the primary air damper positioned to maintain maximum specified primary airflow.

☐i. Simulate a drop in room temperature by slowly raising the room thermostat setpoint.

☐j. Verify that the primary air damper begins to move from the maximum primary position toward minimum position. While the hot water valve remains positioned closed. Confirm the fan remains running at all times.

☐]k. Simulate a continued drop in room temperature by slowly raising the room thermostat setpoint.

☐l. Verify that the primary air damper positions to minimum position, and the hot water valve just begins to move open.

☐m. Simulate a continued drop in room temperature by raising the room thermostat setpoint further.

☐n. Verify that the primary air damper maintains minimum primary airflow. Confirm that the hot water valve positions to the full open position.

B. Unoccupied Mode Controls Tests

1. Test Space Temperature Control Modes

☐a. From an initial warm room temperature condition, verify that the hot water control valve is fully closed, the box fan de-energized, the main air handler fan de-energized and the primary air damper positioned fully closed.

☐ b. Simulate a drop in room temperature by slowly raising the room night thermostat setpoint.

☐c. Verify that the hot water valve opens to the full open position. While the primary air damper remains positioned fully closed. Confirm the box fan is energized.

☐ d. Simulate a rise in room temperature by lowering the room night thermostat setpoint.

☐]e. Verify that the hot water control valve positions fully closed, and the primary air damper remains closed. The box fan is de-energized.

Box Mark	Testinq Completed	Remarks
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
12		
13		
14		

TAB G

DALTS

DUCT AIR LEAKAGE TESTS (DALTS): AN INTRODUCTION

Experience has shown that excessive duct air leakage has been a chronic problem associated with HVAC installations. We have repeatedly encountered HVAC systems during TABS that have experienced leakage rates in low pressure systems far in excess of normally acceptable rates of five to ten percent. Leakage rates upward of forty-five percent have not been uncommon. We can only conclude that either of two things is occurring. Either the workmanship attained on our projects during installation of the sheet metal ductwork has been less than desirable or the need for pressure testing of low velocity/low pressure duct systems runs contrary to the claims of SMACNA. In either case, the leakage rates being encountered were considered to be unacceptable from a system performance standpoint.

To achieve less duct leakage, requirements have been incorporated into Specification Section 15950 to require the Contractor to conduct a pressure test of the installed ductwork to quantify the leakage rate of installed systems. These tests are required to be conducted in accordance with SMACNA's Duct Air Leakage Test Manual. In utilizing DALTS, the quality assurance applied to the workmanship of the installed ductwork becomes less subjective in that a quantitative test method is utilized for evaluating acceptability. Also, the leakage rate of can be assessed at a time which would allow corrective measures to be taken with minimal delays and/or rework.

In the past, excessive duct leakage was not discovered until the TABS data was compiled and reported. This would normally have occurred after the ductwork had been insulated and all dropped ceilings installed. Corrective measures at that point would normally have been both costly and disruptive. The removal of ceilings and the removal of installed duct insulation would have been necessary. To further familiarize the reader with this process, the following provides a description of the submittals and work activities associated with DALTS.

DALTS: SUBMITTALS AND WORK ACTIVITIES

Step 1 (Designer Determines Testing Requirements) - It is the designer's responsibility to determine the extent of duct testing required on each project. Typically, the designer is to identify which duct systems are to be tested, what seal class is required for each duct system, the required pressure class for each duct system, the leakage class required for each system, and the test pressure that each duct system is to be tested at. All of this information must be included either on the drawings or in the specifications. If the designer fails to provide this information, a contractually enforceable duct leakage test has not been adequately defined.

Step 2 (Pre-DALT'S Meeting) - After contract award, the Contractor meets with the TABS Engineer and the Contracting Officer to review the DALTS contractual requirements and the Contractor's scope of work and to make sure that no misunderstandings exist.

We wish to emphasize the importance of discussing the need for the Contractor to provide flanged duct connections liberally installed throughout the duct system which can easily be disconnected/reconnected. The testing is normally conducted on a random basis with only select portions of the duct system being tested. It is very much to the Contractor's advantage to provide means for disconnecting and temporarily blind flanging the ductwork to facilitate testing which requires minimal effort on the sheet metal Contractor's part.

Step 3 (Notice of Duct System Installation Completion) - After completing the installation of the ductwork for a given HVAC system, the Contractor is required by contract to provide notice to the Government within five days. This provides notice to the Government that the Contractor wishes to conduct DALTS testing on the system and that they are awaiting information to be provided by the Government as required under Step 4.

Step 4 (Contracting Officer Selects Duct Sections To Be Tested) - On receipt of notification from the Contractor, as described by Step 3, the Contracting Officer will then determine which portions of the duct system are to be leak tested. Typically, this function will be conducted by the project assigned Construction Representative. The Contractor must be provided with the location of the desired test duct sections within seven days after the Construction Representative has received notice from the Contractor. The purpose of this requirement is to avoid providing any advance notice to the Contractor of intended test locations. This prevents any special workmanship/treatment being applied to the designated duct test sections which might negate the validity of random testing.

Step 5 (Notice of DALTS Work Starting) - The Contractor is required to provide fourteen days notice prior to start of the DALTS. This gives the Government the opportunity to arrange for personnel to be in attendance, if they so choose, during the actual testing.

Step 6 (DALTS Field Work Commences) - After the Contractor receives selections of the duct sections to be tested, he is then authorized to proceed with the DALTS testing on the system in question. The test duct sections are isolated with blind flange connections. The pressure blower assembly and calibrated airflow orifice, as prescribed by the SMACNA Duct Leakage Test Manual, are utilized for testing.

Step 7 (TABS Supervisor Field Visit) - The TABS Supervisor is required to visit the jobsite sometime during the field testing to validate that proper test procedures are being implemented by the TABS Field Leader. The length of this visit is required to be of sufficient duration to allow the TABS Supervisor to certify that proper procedures have been complied with during the testing.

Step 8 (Verbal Notice of DALTS Completion) - Once the Contractor has completed the DALTS testing on a given system, notification is issued to the Contracting Officer, which places the Government on notice that the DALTS Field Check will be conducted in ***forty-eight hours***.

Step 8a (Prepare Pre-final DALTS Report) - Concurrent with Step 8, the TABS Field Leader compiles a pre-final report. This report is submitted to the ROICC for use in conducting a DALTS Field Check. The Contractor is required to submit the report within one day after completing the DALTS testing.

Step 9 (Conduct DALT'S Field Check) - The Contractor and the Contracting Officer's Representative (usually, the Construction Representative) will meet, and the Contractor will demonstrate the repeatability of the test data. All duct systems are required to be successfully tested prior to being insulated. <u>Steps 2 through 9 are to be repeated for each respective duct system that is required to undergo duct leakage testing</u>.

Step 10 (Preparation and Submittal of Final DALTS Report) - On completion of testing and field check of all systems, the TABS Supervisor will compile the test data for each system into a final certified report. This report is then submitted as a final record document indicating completion of testing. This document is then submitted for final review for completeness and approval.

A flow diagram follows which provides a graphic representation of DALTS. Note that the process diagram represents the steps taken for only one duct system. The process must be repeated for each of the installed duct systems that are specified to be leak tested.

Please note that we have enclosed a copy of the Duct Construction and Leak Test Schedule, which will be incorporated into the construction drawings on each project requiring DALTS.

FILENAME: FINALDALTS.DWG, UPDATED ON 12/20/01 AT 14:29, XREFS: NONE

ASHRAE 90.1 RECOMMENDED MINIMUM DUCT SEAL CLASS				
DUCT LOCATION	DUCT TYPE			
	SUPPLY		EXHAUST	RETURN
	≤2 IN WC	>2 IN WC		
OUTDOORS	A	A	C	A
UNCONDITIONED SPACES	B	A	C	B
CONDITIONED SPACES	C	B	B	C

INCLUDES INDIRECT CONDITIONED SPACES SUCH AS RETURN AIR PLENUMS

TEST PRESSURE SHALL EQUAL TO DUCT PRESSURE CLASS RATING IN INCHES WATER COLUMN. NOTE: ONLY USE POSITIVE PRESSURE FOR TEST PRESSURE SINCE DUCTWORK IS NOT TESTED UNDER NEGATIVE PRESSURE.

IF USING ROUND OR OVAL DUCT REMEMBER TO SPEC THE RECTANGULAR DUCT OUT OF THE FAN.

CAN BE POSITIVE OR NEGATIVE

DUCT CONSTRUCTION AND LEAK TEST SCHEDULE

MARK	DUCT PRESSURE CLASS INCHES WATER COLUMN				SUPPLY				RETURN/ OUTSIDE AIR		DUCT TEST PRESSURE INCHES WATER COLUMN	REMARKS
					ROUND/OVAL		RECTANGLE					
	SUPPLY DUCT	RETURN DUCT	EXHAUST DUCT	OUTSIDE AIR DUCT	DUCT SEAL CLASS	DUCT LEAK CLASS	DUCT SEAL CLASS	DUCT LEAK CLASS	DUCT SEAL CLASS	DUCT LEAK CLASS		
PACKAGED ROOFTOP UNIT–VAV	4	–	–	–	A	3	A	6	–	–	4.0	1
	–	–2	–	–	–	–	–	–	C	24	2.0	1
PACKAGED ROOFTOP UNIT–CONST VOLUME	2	–	–	–	–	–	C	24	–	–	2.0	1
	–	–1	–	–	–	–	–	–	C	24	1.0	1
AIR HANDLING UNIT WITH ECONOMIZER–CONSTANT VOLUME	2	–	–	–	C	12	C	24	–	–	2.0	1
	–	–1	–	–	–	–	–	–	C	24	1.0	1
	–	–	–.5	–	–	–	C	24	–	–	.5	1
	–	–	–	–1	–	–	–	–	C	24	1.0	1
SERIES VAV UNITS	2	–	–	–	–	–	C	24	–	–	2.0	1
	–	–.5	–	–	–	–	–	–	C	24	.5	1 2
EXHAUST DUCT	–	–	–1	–	–	–	C	24	–	–	1.0	1
EXHAUST DUCT	–	–	–1	–	–	–	C	24	–	–	1.0	2

1 TEST IN ACCORDANCE WITH SPEC SECTION 15950, HVAC TESTING/ADJUSTING/BALANCING AND THE PROCEDURES IN SMACNA HVAC AIR DUCT LEAKAGE TEST MANUAL, 1985 EDITION.

2 NO TEST REQUIRED

NOT ALL DUCT REQUIRE TESTING. USE JUDGMENT

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION
NORFOLK, VIRGINIA

LANTDIV SKETCH NO.
DATE: 12–20–01
THIS SKETCH REVISES IN PART NAVFAC DWG. NO.

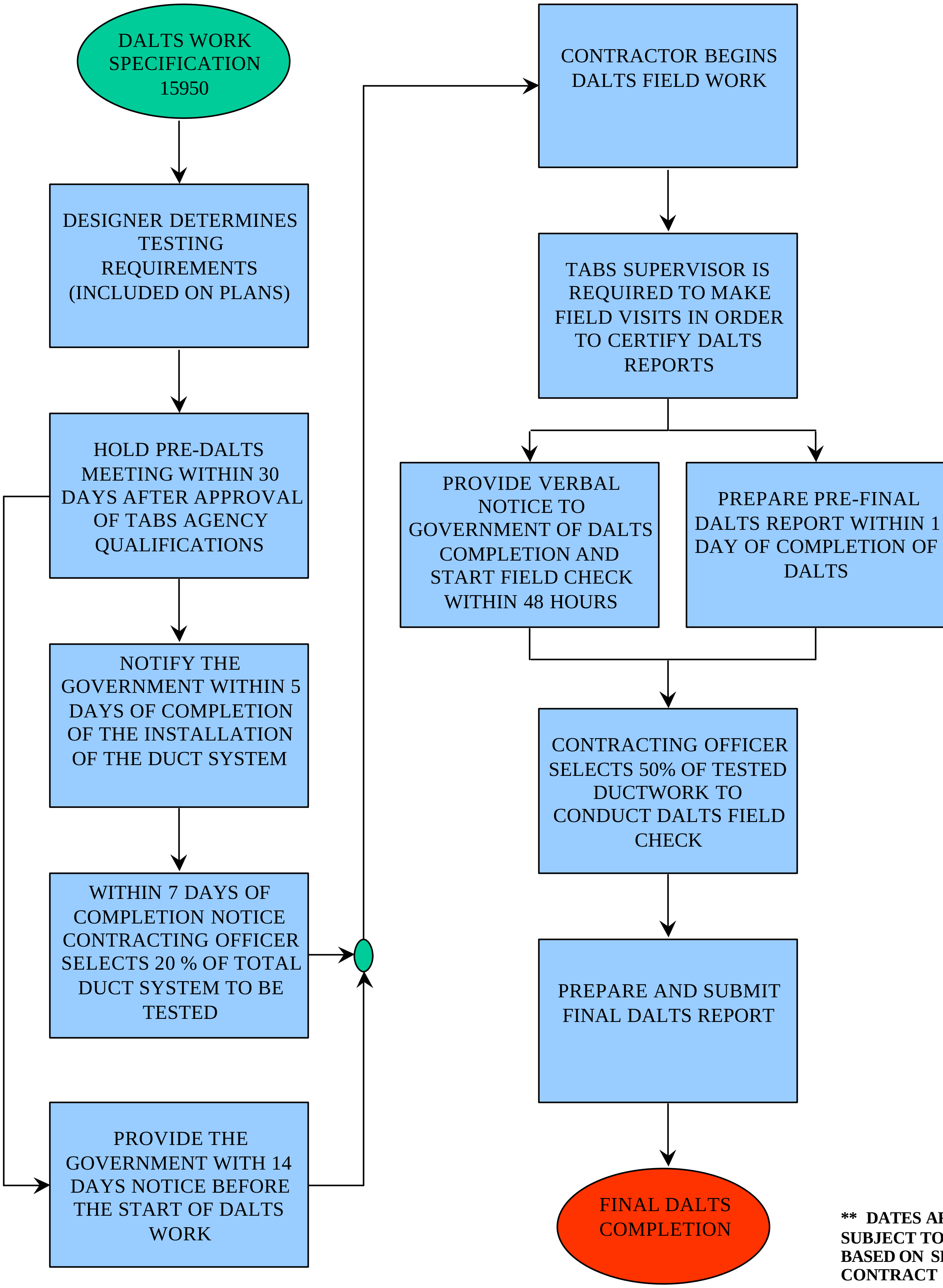
DUCT CONSTRUCTION AND LEAK TEST SCHEDULE

DESIGN: JTI
DRAWN: ____
REVIEW: ____
SPEC. NO.
CONSTR. CONTR. NO.

SAMPLE

DESIGNED & ENGINEERED BY: LANTDIV
NAVAL FACILITIES ENGINEERING COMMAND

REVISION 12 DEC 2000



**** DATES ARE SUBJECT TO CHANGE BASED ON SPECIFIC CONTRACT REQUIREMENTS**

DALTS OVERALL PROCESS

TAB H

CONSTRUCTABILITY REVIEWS

CONSTRUCTABILITY REVIEWS

Experience has shown that certain problems have been encountered on a repeated basis in association with HVAC designs. To assist in identifying some of these items during the ROICC constructability review, the following provides a listing which has been formatted to allow it's use as a checklist during the review process. We highly encourage the use of this listing and ask you to question/comment when any of the items described are not satisfactory:

❑Verify that duct leakage tests (DALTS) have been specified in Specification Section 15950 for all projects having extensive duct systems.

❑Verify that a schedule has been included on the drawings showing duct pressure class, duct seal class, duct leakage class, duct test pressure, and duct to be tested, when duct leakage testing is required in Specification Section 15950.

❑Verify on those projects which have not included duct leakage in Specification Section 15950 that minimal leak testing has been included in Specification Section 15700. Specification Section 15700 should specify that all duct surfaces are to be checked by hand to locate any leakage that can be felt by touch with the fan operational. Also, verify that the specification explicitly states that the ductwork will not be insulated until leakage tests are completed.

❑Verify that manual volume dampers are indicated for <u>all</u> branch main and branch ducts. This should include all supply, return, and exhaust ductwork. Dampers at the terminal outlet should never be used as the primary balancing device.

❑Verify that splitter dampers are not specified in lieu of balancing dampers. Splitter dampers are not endorsed by SMACNA for balancing applications.

❑Verify that all air handlers of 2000 CFM or more, which have dry bulb economizers, have both a minimum and a maximum automatic outside air damper.

❑Verify that an opposed blade manual balancing damper is shown on both the minimum outside air duct and the maximum outside air duct where max/min automatic outside air dampers are specified for air handlers.

❑Verify that an opposed blade manual balancing damper is shown for both the main return duct and the main relief duct on all return air fans. These dampers should be in close proximity to the automatic return and relief dampers.

❑Verify that access doors are shown on the drawings for all automatic control dampers and duct mounted coils. The location and size of the access doors should be clearly shown and reasonable for providing service access.

❑Verify that flexible duct lengths shown on the drawings are never in excess of six feet in length. Invariably, longer lengths have been a problem.

❑Verify that ducted fans have sufficient lengths of straight ductwork to allow duct traverses to be taken. A minimum of seven and one half duct lengths of straight duct should be provided downstream of duct fittings/components. Two and one half duct lengths should be provided upstream of fittings/components.

❑Verify that, where possible, minimum outside air ducts are sized at no lower than 800 feet per minute velocity to allow accurate traversing. Verify that the outside air duct provides a straight section of duct to allow accurate traversing.

❑Verify for all variable air volume terminal boxes that the primary air supply inlet ducts have a straight entry into the boxes. The ducts should have specified at least three feet, or 6 duct diameters, of straight length.

❑Verify for all variable air volume terminal boxes that the minimum primary airflow rates specified are <u>never</u> less than twenty-five percent of the specified maximum primary airflow rates.

❑Verify that drawing details of powered roof exhaust ventilation fans include a requirement for airtight caulking between the fan frame and the wood nailer of the roof curb.

❑Verify that flow control balancing valves (circuit setters) are shown for all heating and cooling coil details on the drawings, including computer room air conditioning units.

❑Verify for <u>all</u> circuit setters detailed on the drawings that a note is included requiring the device to be installed in accordance with the manufacturer's recommendations regarding the minimum straight lengths of pipe both up and downstream of the circuit setter.

❑Verify where symbols are used on the drawings to specify the locations of flow control balancing valves (circuit setters) that the terminology used on the symbol legend is completely consistent with the terminology used in Specification Section 15700.

❑Verify that all pumps are specified with a circuit setter on the pump discharge. For pipe sizes larger than three inches, a flow orifice combined with a butterfly valve should be specified. Make sure that these features are shown on the drawing pump details.

❑Verify for all cooling towers, which are specified to have a condenser water bypass for regulating the condenser water supply temperature, that a butterfly valve is specified to be installed in the bypass line.

❑Verify where multiple chillers are specified serving a common central chilled water system that a flow control balancing valve (circuit setter) is specified to be installed on the leaving side of both the chilled water and condenser water (where applicable) of each chiller. Flow orifices with butterfly valves should be provided for larger pipe sizes.

❑For all air conditioning which must operate year-round, such as those serving computer spaces, verify that low ambient controls have been specified for the condensing units.

❑There are several time constraints placed on the Contractor with regard to the TABS submittals and work activities. The time allocated for completion of this work, relative to the contract calendar days specified, should be examined closely and verified to be adequate.

❑For projects having multiple phases of construction, verify that the TABS submittals are specified to be provided for each distinct phase. Use of a single Season I submittal for the entire project is not acceptable.

❑Some projects which have multiple phases of construction, or which have several buildings served from central hot water/chilled water district plants, may necessitate balancing to be accomplished more than once as work progresses. Verify that such situations have been adequately addressed in the specifications.

❑Verify that a schedule is shown on the drawings which identifies the indoor and outdoor design conditions for all of the HVAC systems.

❑Note that when reviewing multi-trade, JOC, TOC, BPA etc. contracts that the contract specifications may not address TABS/ACATS/DALTS as thoroughly as the typical construction contracts. It is important that the contract requirements be reviewed without assuming that LANTDIV guide specifications have been used or referenced completely or even partially. Like all specifications, the first step is to read the specification to determine the requirements. This is true also for Design/Build contracts: Review the specifications to verify what is included and refer to the RFP to insure that the all the requirements contained in the RFP have been included in the specification.

TAB I

COMMON PROBLEMS

COMMON TABS RELATED CONSTRUCTION PROBLEMS

Experience has shown that there are certain problems which seem to repeat themselves from project-to-project. We have provided a listing below which can be used as a checklist on your projects. We encourage you to use this list early, and often, as an assist in avoiding rework and costly delays.

TABS ITEMS:

❑Carefully check heating and cooling coil connections to verify that they are piped correctly to the coil inlet/outlet. If proper connections cannot be verified from the submittal data, request the Contractor to obtain information from the coil manufacturer.

❑Carefully check all installed steam and water automatic control valves to verify that they are piped correctly. Also, confirm that the valves have the correct normal position and the valve ports are connected into the pipe circuit in the correct direction. Insist on the valves being checked prior to the associated piping being insulated. The checks described should be accomplished using the approved automatic controls shop drawings and manufacturer's catalog data for the valves.

❑Carefully check all heating and cooling coils to verify that flow control balancing valves (circuit setters), thermometers, pressure gages, and specialty valving called for on the drawing details have been installed. Make sure that they are properly located in the piping.

❑Carefully check all water pumps to verify that flow control balancing valves (circuit setters), pressure gages, and specialty valving called for on the drawings have been installed.

❑Verify that flow control balancing valves (circuit setters) are correctly installed in the water piping. There should be a minimum length of straight pipe, both up and downstream of the valve, which is free of any pipe fittings, valves, or other appurtenances. This distance is prescribed in the valve manufacturer's literature; insist that the Contractor strictly adhere to this requirement.

❑Confirm that all water systems are thoroughly flushed and all air removed before allowing balancing to proceed. Make certain that the Contractor removes all fine mesh start-up strainers from suction diffusers on pumps after the initial start-up.

❑Verify that manual volume dampers are installed at all locations shown on the drawings.

❑Where opposed blade manual volume dampers are specified, verify that the Contractor does not install a single blade leaf damper instead. The single blade damper is cheaper and provides less precise adjustment of airflow.

❑Verify that turning vanes are installed in all 90 degree miter (square) elbows for supply, return, and exhaust ductwork.

❑Verify that access doors have been installed at all automatic control dampers installed in the ductwork. The access doors should be placed and be of a size that will allow for adequate maintenance access in the future.

❑Verify that all supply, return, and exhaust terminal outlets, such as diffusers, registers, and grilles, are properly terminated at the ceiling. We frequently find that these outlets are installed with a flanged sleeve that terminates on the top face of the ceiling tile with significant leakage occurring.

❑Where flexible duct has been installed, make sure the lengths are not excessive (normally not over 6'-O"). Duct runs should be properly supported, with no surplus duct length or sagging. Kinks and unnecessary turns/offsets in the ducts should not be permitted. Verify that the duct is properly terminated with either a nylon or stainless steel draw band.

❑Where flexible duct has been installed, verify that all duct support hangers are of sufficient width to avoid damage to the duct vapor seal. Use of bailing wire as a hanger affixed directly to the duct is unsatisfactory. Refer to the SMACNA Duct Construction Standards Handbook for proper duct support.

❑Verify that all installed ductwork is properly leak tested prior to allowing the duct work to be insulated.

❑Verify that all powered roof exhaust ventilation fans have an airtight seal between the fan frame and the wood nailer of the roof curb to prevent short circuited airflow.

❑Confirm that back-draft dampers are installed for all powered roof exhaust ventilation fans. Verify that the dampers operate freely and are not prevented from operating due to incorrectly placed sheet metal screws or electrical conduit.

❑Verify for all variable air volume terminal boxes that the primary air supply inlet ducts have a straight entry into the boxes. The ducts should have at least three feet of straight length.

❑On those projects having variable air volume terminal boxes, request that the TABS Engineer, immediately after approval of the TABS qualifications submittal, be tasked with verifying that the specified minimum primary air quantities specified are attainable with the variable air volume terminal boxes that are being submitted for approval on the project. <u>This is the most common design error encountered with regard to variable air volume systems</u>. Early detection and correction of this problem is very important.

❑Verify that adequate access has been provided for all equipment located above ceilings. If you determine that the equipment cannot be properly maintained after installation, then the installation is not acceptable. Correction must be achieved either through the Contractor or the designer, as deemed appropriate.

❑Before the Contractor is permitted to proceed with TABS field work, verify that approval has been received for the TABS Qualifications Submittal, the Pre-field Engineering Report, and the Prerequisite Checklist.

❑Before the Contractor is permitted to proceed with TABS field work, verify that all DALTS work has been completed.

❑Before scheduling the TABS verification, confirm that the TABS Certified Report has been approved.

❑Make sure that LANTNAVFACENGCOM Code CI52, or designated Government TABS representative, has been notified at least ten days in advance prior to conducting TABS field verification.

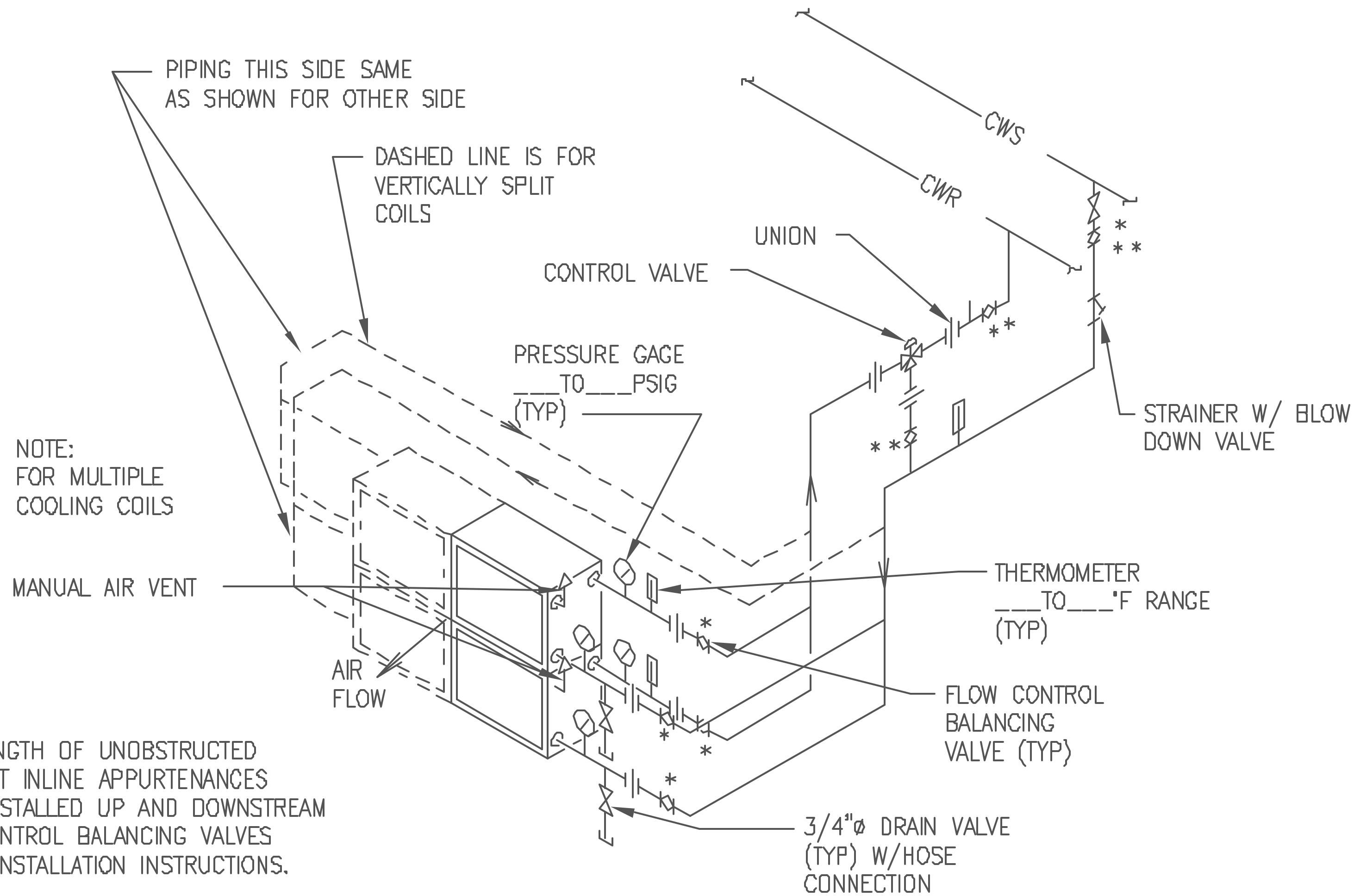
❑Make sure that the ACATS Performance Verification testing is witnessed, in total, by a Government Representative. This is critical to proper ACATS testing.

TAB J

REFERENCE DETAILS

REFERENCE HVAC STANDARD DETAILS

To provide a convenient reference source for use in conducting both constructability reviews and field quality assurance, the following listing of CI43 prepared standard details has been provided. These details are considered to be appropriate for most HVAC applications and are correct representation of what are considered to be minimally acceptably for LANTNAVFACENGCOM projects. When reviewing a design, or when evaluating the acceptability of an installation in the field, these details provide a useful reference.



* STRAIGHT LENGTH OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP AND DOWNSTREAM OF FLOW CONTROL BALANCING VALVES PER MFGR. INSTALLATION INSTRUCTIONS.

** IF PIPE SIZES PRECLUDE USE OF FLOW CONTROL BALANCING VALVES USE FLOW INDICATOR SCHEME. SEE DETAIL

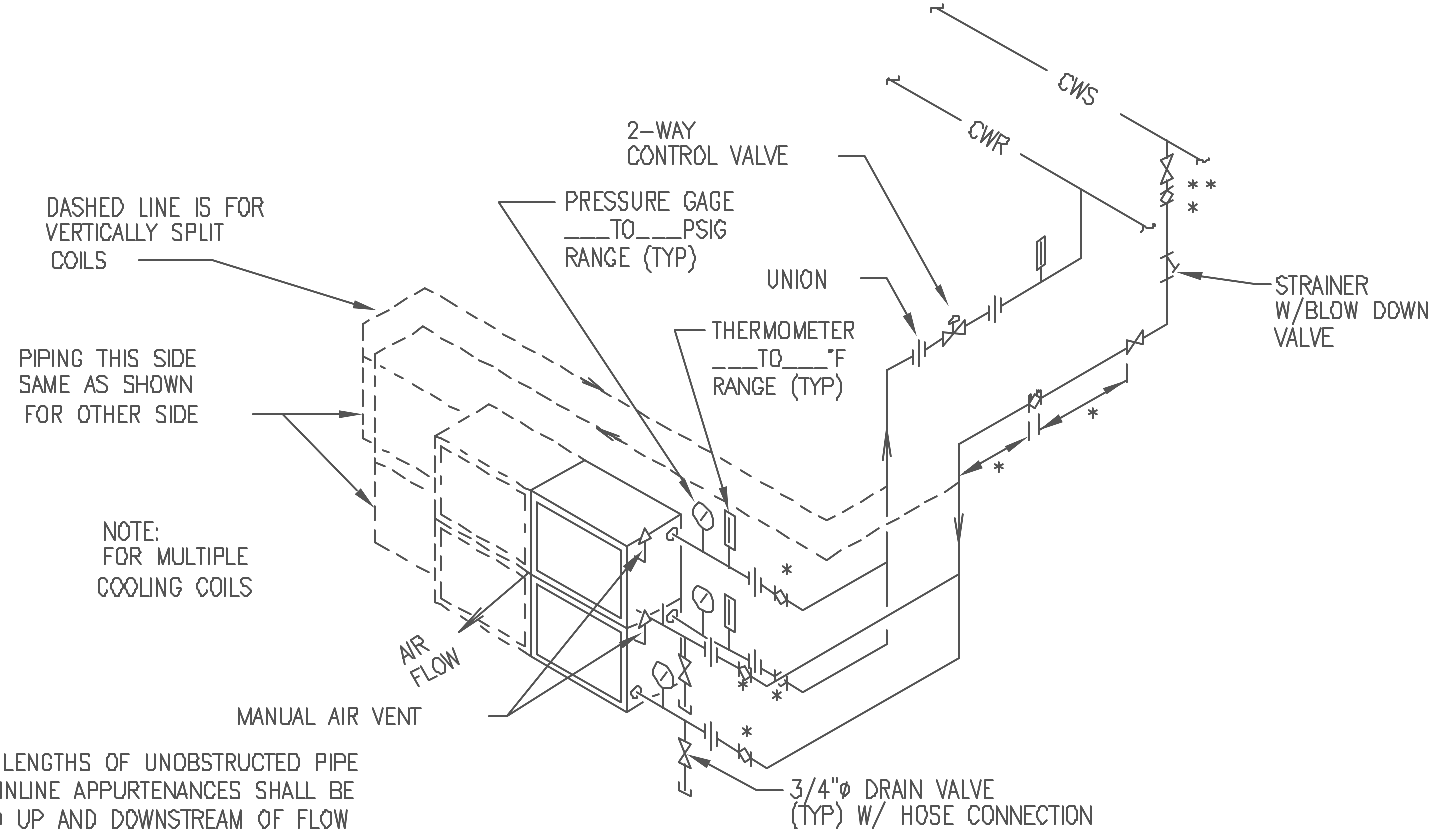
(3-WAY VALVE)

COOLING COIL PIPING DETAIL

NO SCALE

WHERE COIL IS SPLIT INTO (2) OR MORE SECTIONS, EACH SECTION SHALL BE PIPED SEPARATELY

Detail #1



* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP AND DOWNSTREAM OF FLOW CONTROL BALANCING VALVES PER MFGR. INSTALLATION INSTRUCTIONS.

** IF PIPE SIZES PRECLUDE USE OF FLOW CONTROL BALANCING VALVES USE FLOW INDICATOR SCHEME. SEE DETAIL

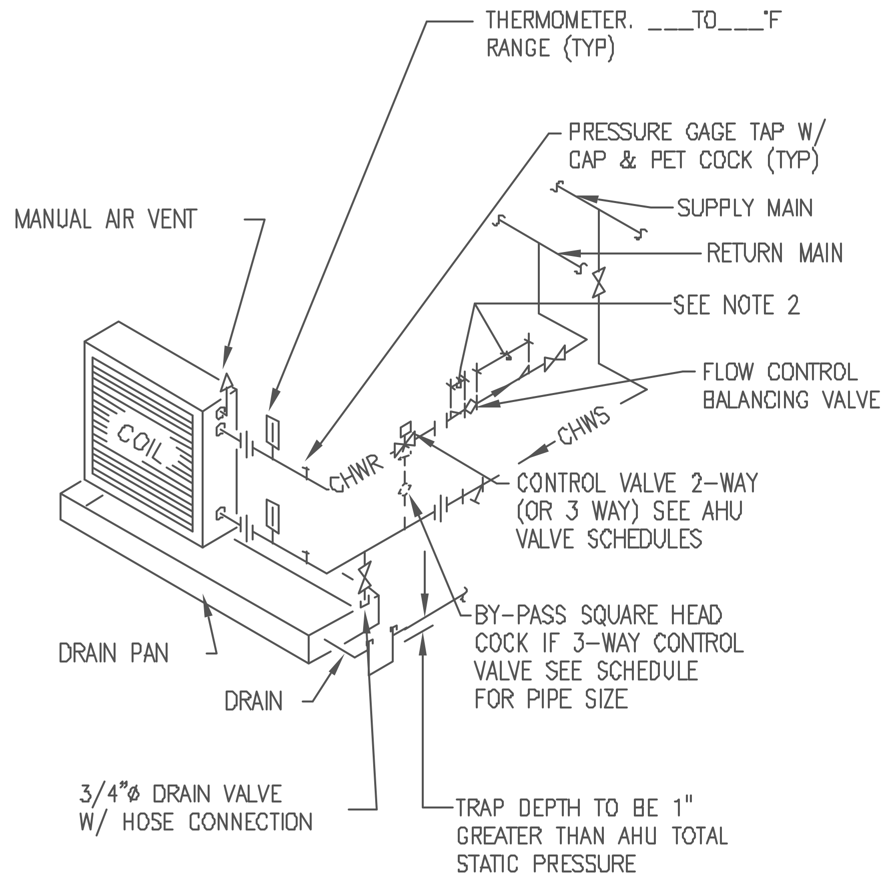
(2-WAY VALVE)

COOLING COIL PIPING DIAGRAM

NO SCALE

WHERE COIL IS SPLIT INTO (2) OR MORE SECTIONS, EACH SECTION SHALL BE PIPED SEPARATELY

Detail #2



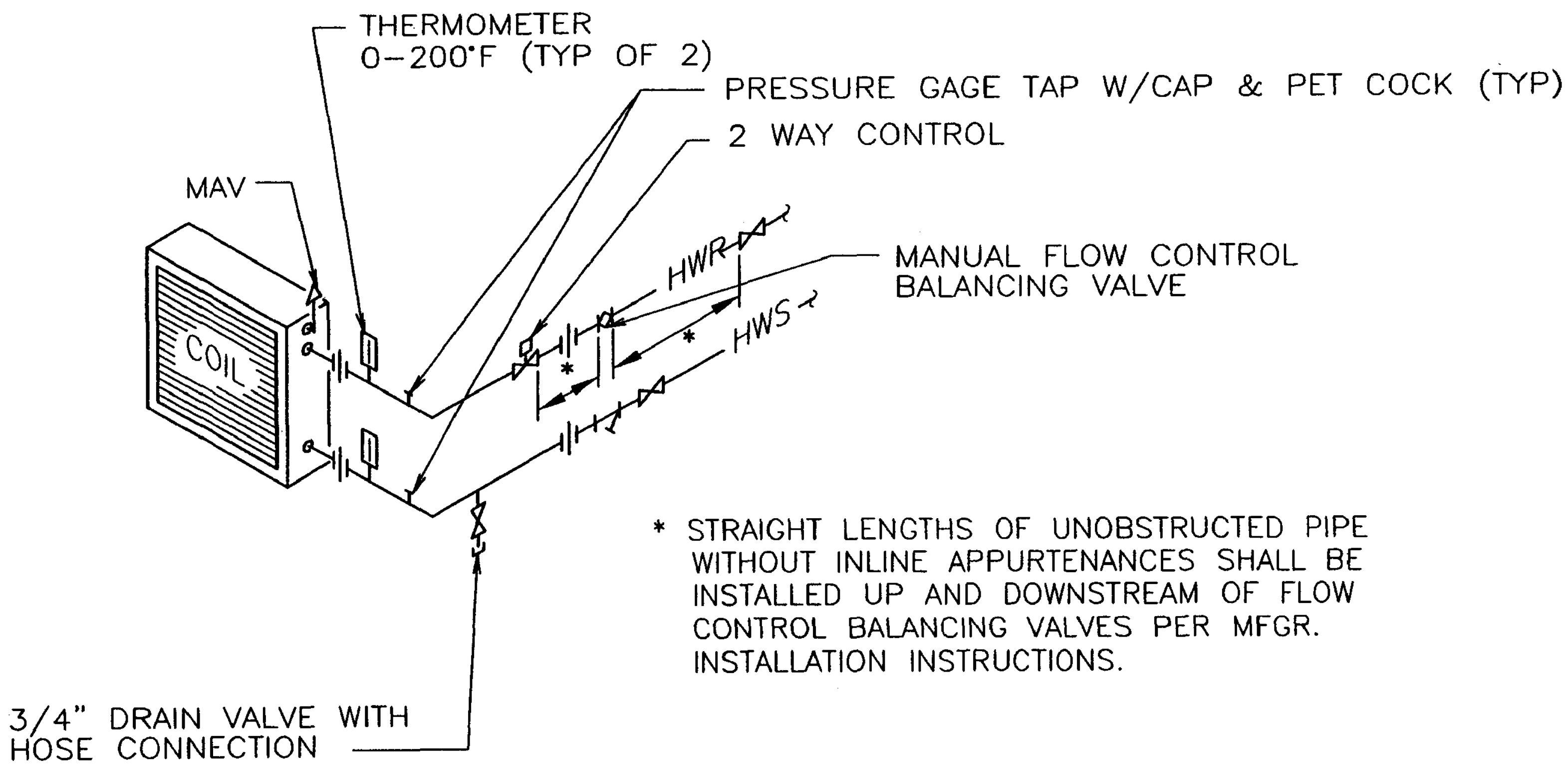
NOTE: 1. ARRANGE PIPING TO PERMIT REMOVAL OF COIL.

2. THE FLOW CONTROL BALANCING VALVES SHALL BE INSTALLED BY THE CONTRACTOR IN CONFORMANCE WITH VALVE MFGR'S RECOMMENDED SPACING UP/ DOWNSTREAM FORM PIPE CHANGES IN DIRECTION AND/OR OTHER VALVES/COMPONENTS IN THE PIPING.

A.H.U. COIL PIPING DETAIL

NO SCALE

Detail #3

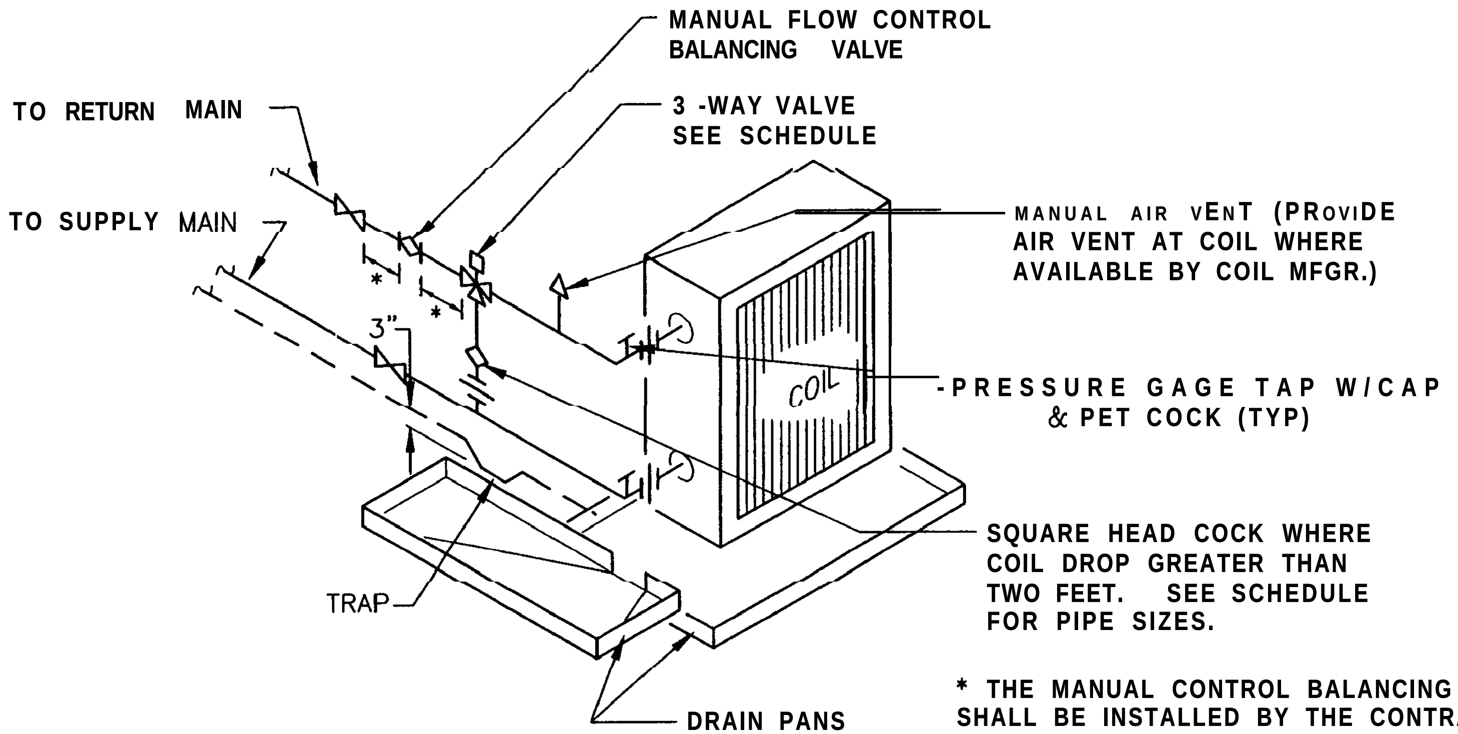


* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP AND DOWNSTREAM OF FLOW CONTROL BALANCING VALVES PER MFGR. INSTALLATION INSTRUCTIONS.

HOT WATER COIL PIPING DETAIL

NO SCALE

Detail #4



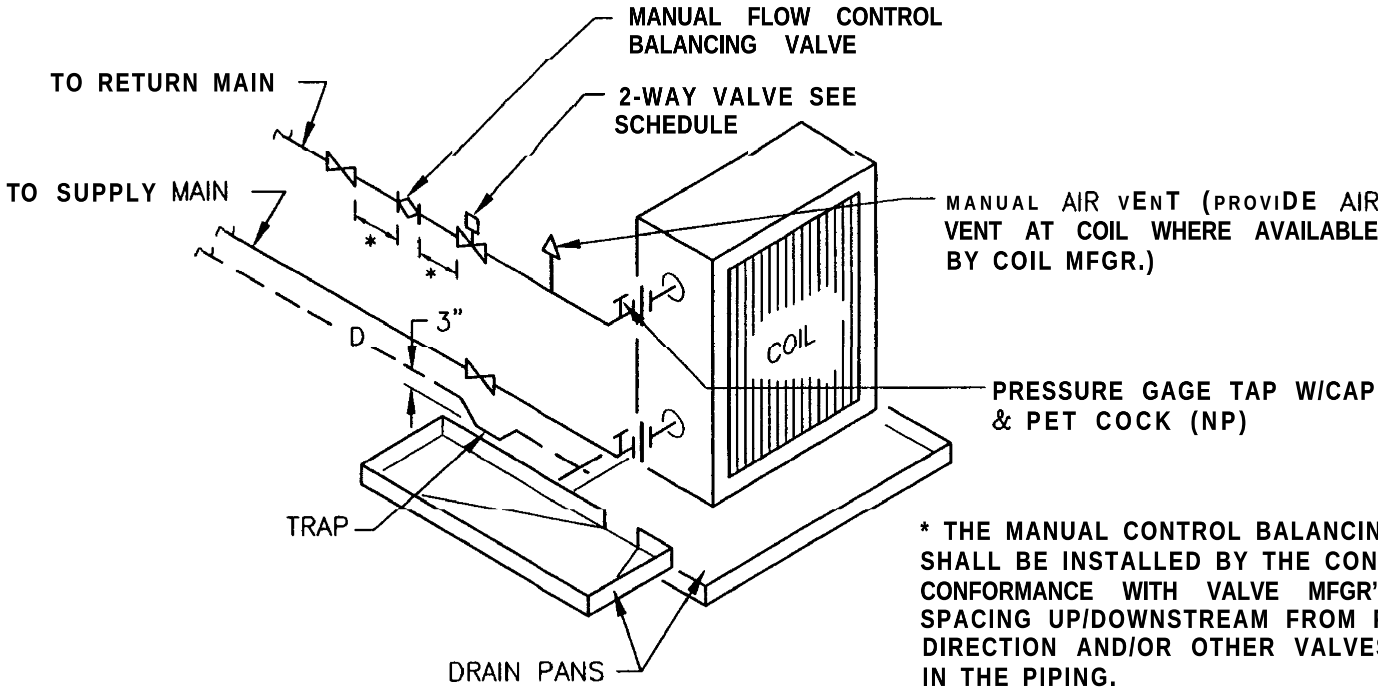
* THE MANUAL CONTROL BALANCING VALVES SHALL BE INSTALLED BY THE CONTRACTOR CONFORMING WITH VALVE MFGR'S RECOMMENDED SPACING UP/DOWNSTREAM FROM PIPE CHANGES IN DIRECTION AND/OR OTHER VALVES/COMPONENTS IN THE PIPING.

3-WAY VALVE PIPING CONFIGURATION

FAN COIL UNIT PIPING DETAIL

NO SCALE

Detail #5



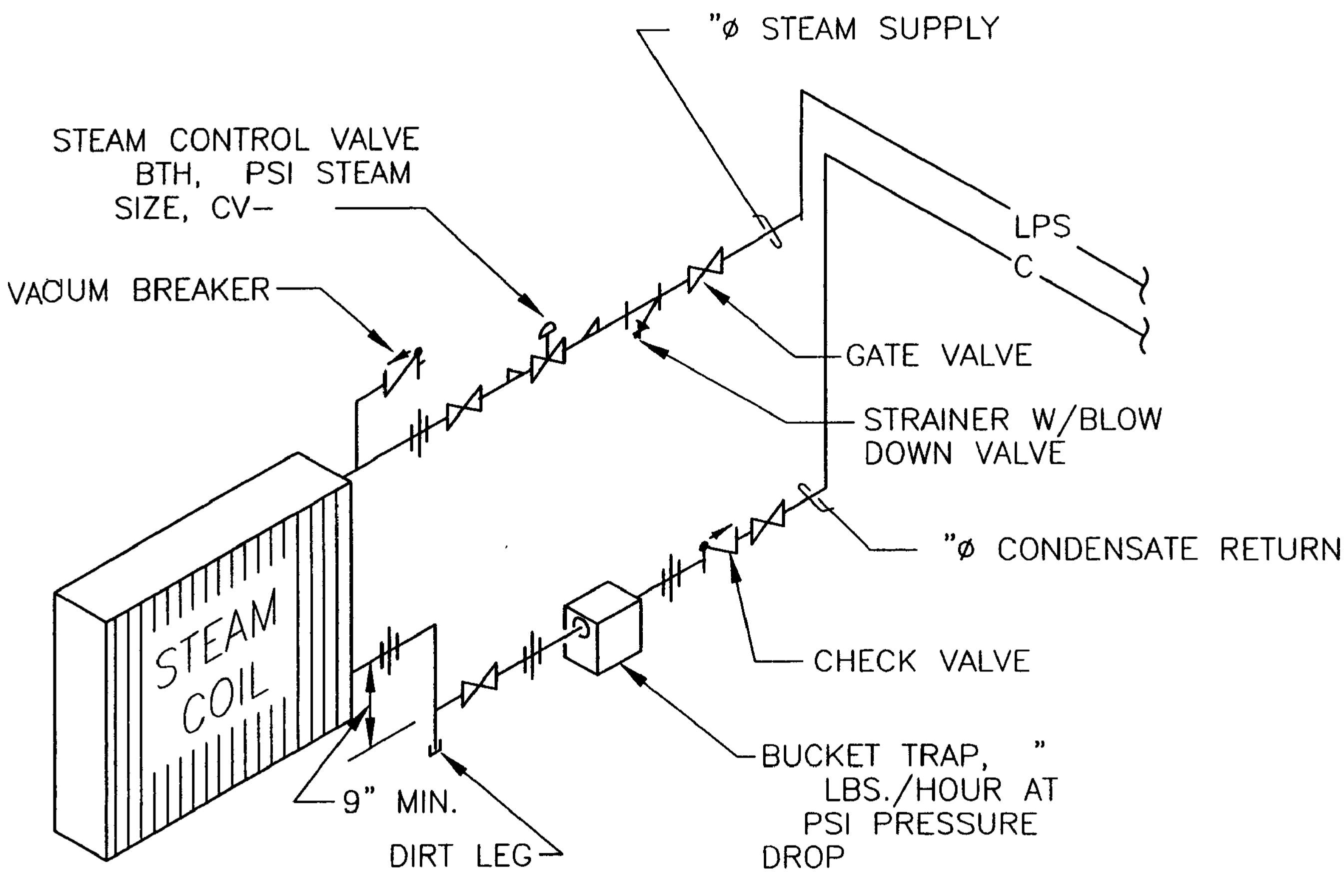
* THE MANUAL CONTROL BALANCING VALVES SHALL BE INSTALLED BY THE CONTRACTOR IN CONFORMANCE WITH VALVE MFGR'S RECOMMENDED SPACING UP/DOWNSTREAM FROM PIPE CHANGES IN DIRECTION AND/OR OTHER VALVES/COMPONENTS IN THE PIPING.

2-WAY VALVE PIPING CONFIGURATION

FAN COIL UNIT PIPING DETAIL

NO SCALE

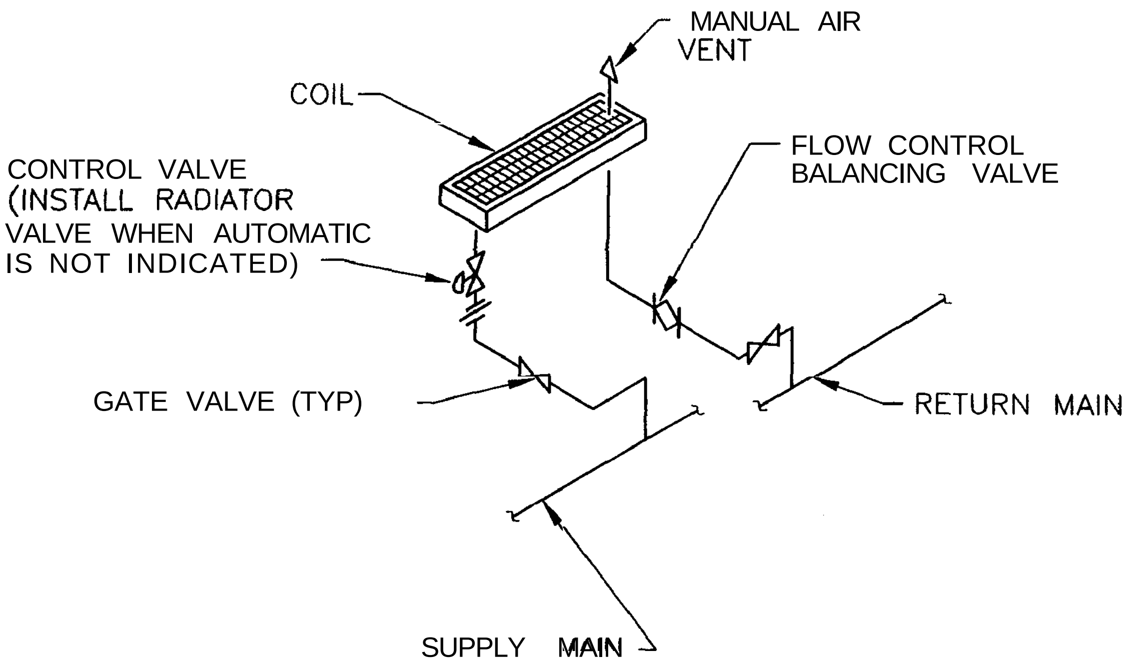
Detail #6



STEAM COIL PIPING DETAIL

NO SCALE

Detail #7



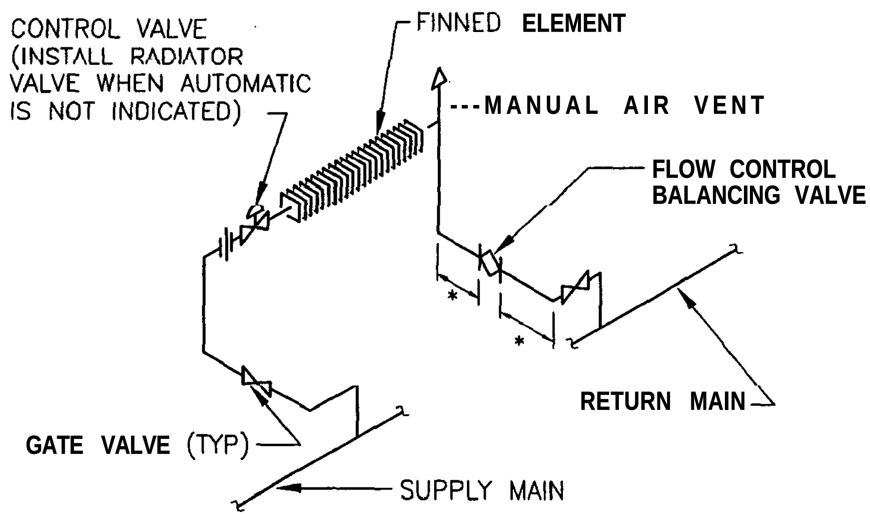
NOTE: 1 LOCATE AIR VENT VALVES ABOVE CEILING EXCEPT WHERE INACCESSABLE OR EXPOSED PIPING LOCATE IN UNIT CABINET.

2. THE FLOW CONTROL BALANCING VALVES SHALL BE INSTALLED BY THE CONTRACTOR IN CONFORMANCE WITH VALVE MFGR'S RECOMMENDED SPACING UP/DOWNSTREAM FROM PIPE CHANGES IN DIRECTION AND/OR OTHER VALVES/COMPONENTS IN THE PIPING.

BOTTOM FEED HOT WATER CONVECTOR PIPING DETAIL

NO SCALE

Detail #8



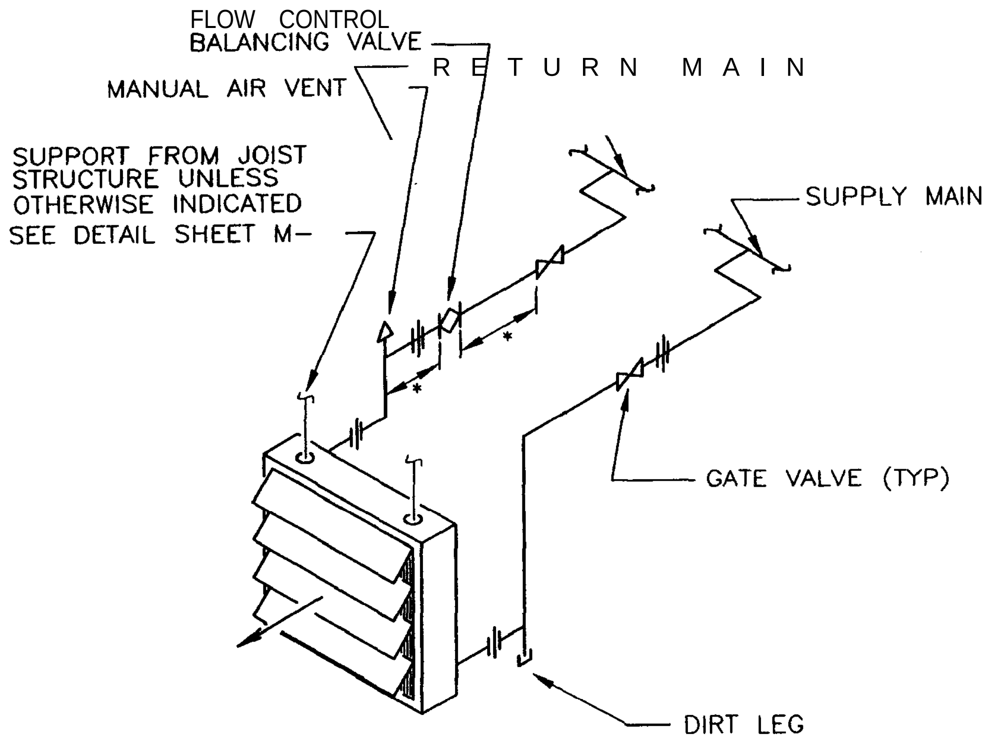
** LOCATE AIR VENT VALVES ABOVE CEILING EXCEPT
WHERE INACCESSABLE OR EXPOSED PIPING
LOCATE IN UNIT CABINET

* THE FLOW CONTROL BALANCING VALVES SHALL BE
INSTALLED BY THE CONTRACTOR CONFORMING WITH
VALVE MFGR'S RECOMMENDED SPACING UP/DOWNSTREAM
FROM PIPE CHANGES IN DIRECTION AND/OR OTHER
VALVES/COMPONENTS IN THE PIPING.

UP FEED HOT WATER FINTUBE PIPING DETAIL

NO SCALE

Detail #9



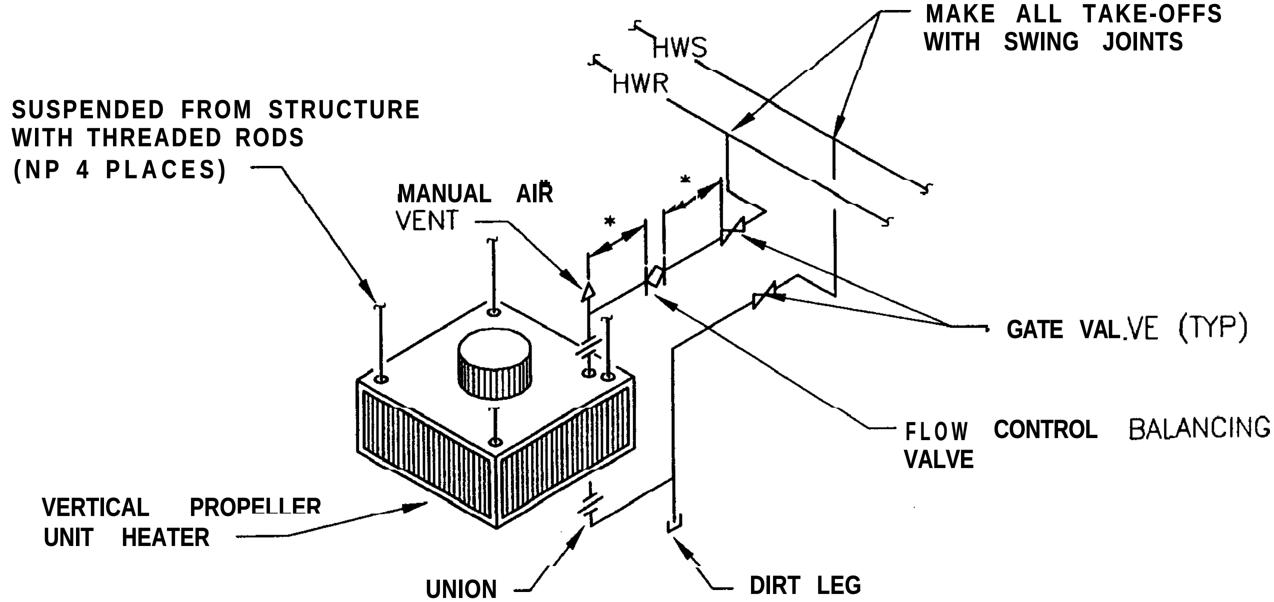
* THE FLOW CONTROL BALANCING VALVES SHALL BE INSTALLED BY THE CONTRACTOR IN CONFORMANCE WITH VALVE MFGR'S RECOMMENDED SPACING UP/DOWNSTREAM FROM PIPE CHANGES IN DIRECTION AND/OR OTHER VALVES/COMPONENTS IN THE PIPING.

HOT WATER UNIT HEATER PIPING DETAIL

NO SCALE

Detail #10

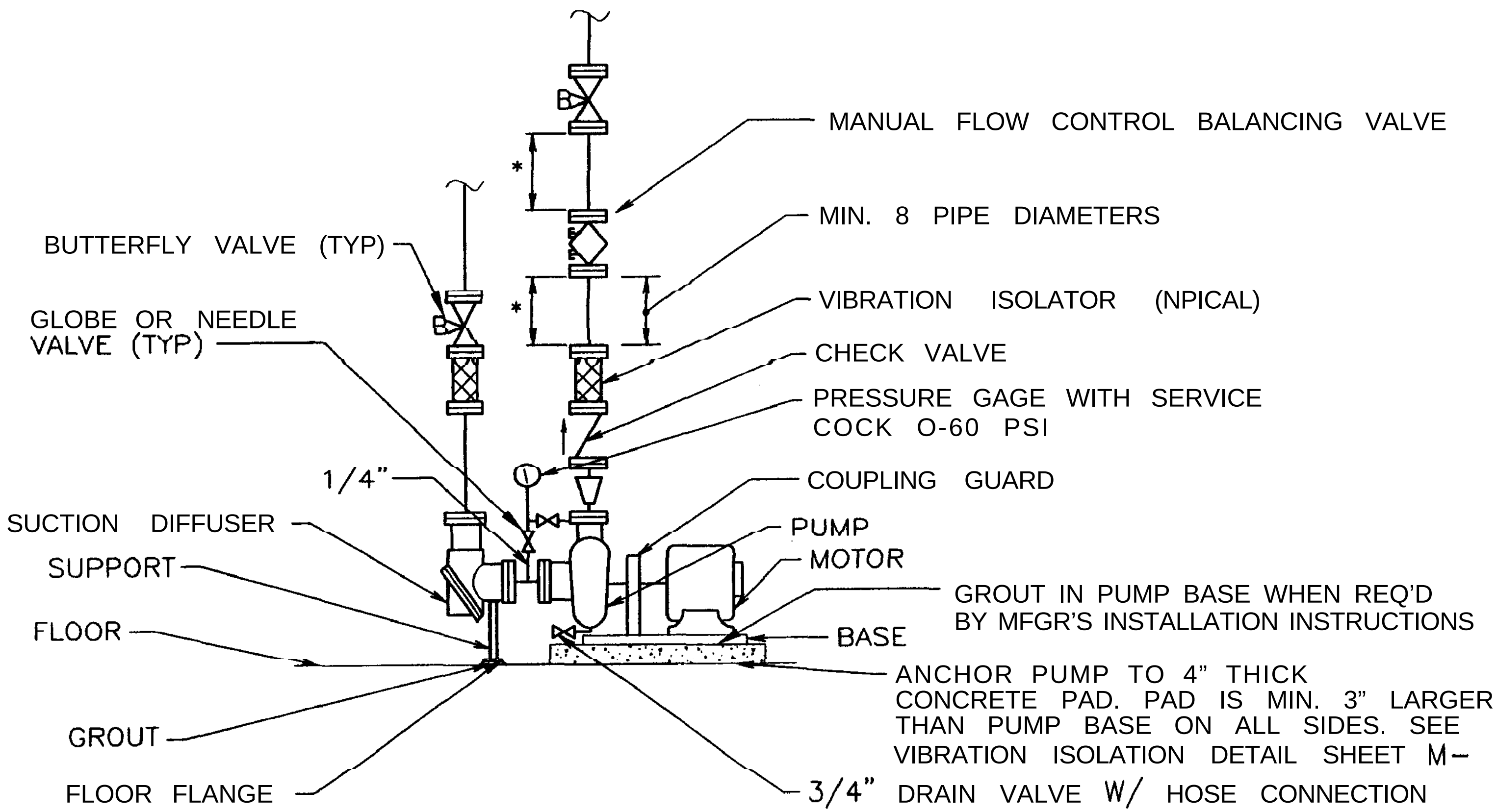
* THE FLOW CONTROL BALANCING VALVES SHALL BE INSTALLED BY THE CONTRACTOR IN CONFORMANCE WITH VALVE MFGR'S RECOMMENDED SPACING UP/DOWNSTREAM FROM PIPE CHANGES IN DIRECTION AND/ OR OTHER VALVES/COMPONENTS IN THE PIPING



HOT WATER VERTICAL UNIT HEATER PIPING DETAIL

NO SCALE

Detail #11

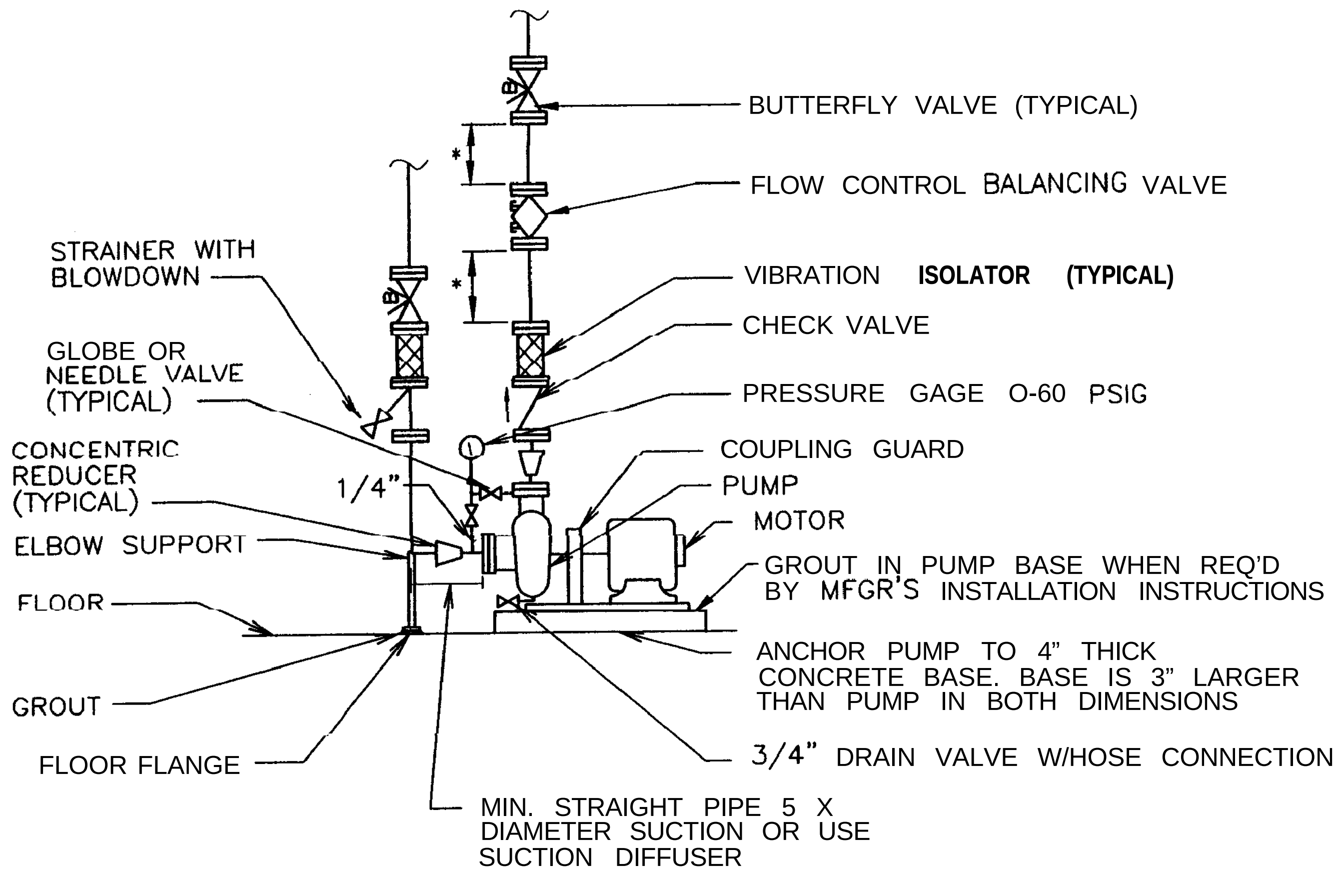


* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP/DOWNSTREAM OF FLOW CONTROL BALANCING VALVE PER MFGR'S INSTALLATION INSTRUCTIONS

BASE MOUNTED CENTRIFUGAL PUMP

NO SCALE

Detail #12

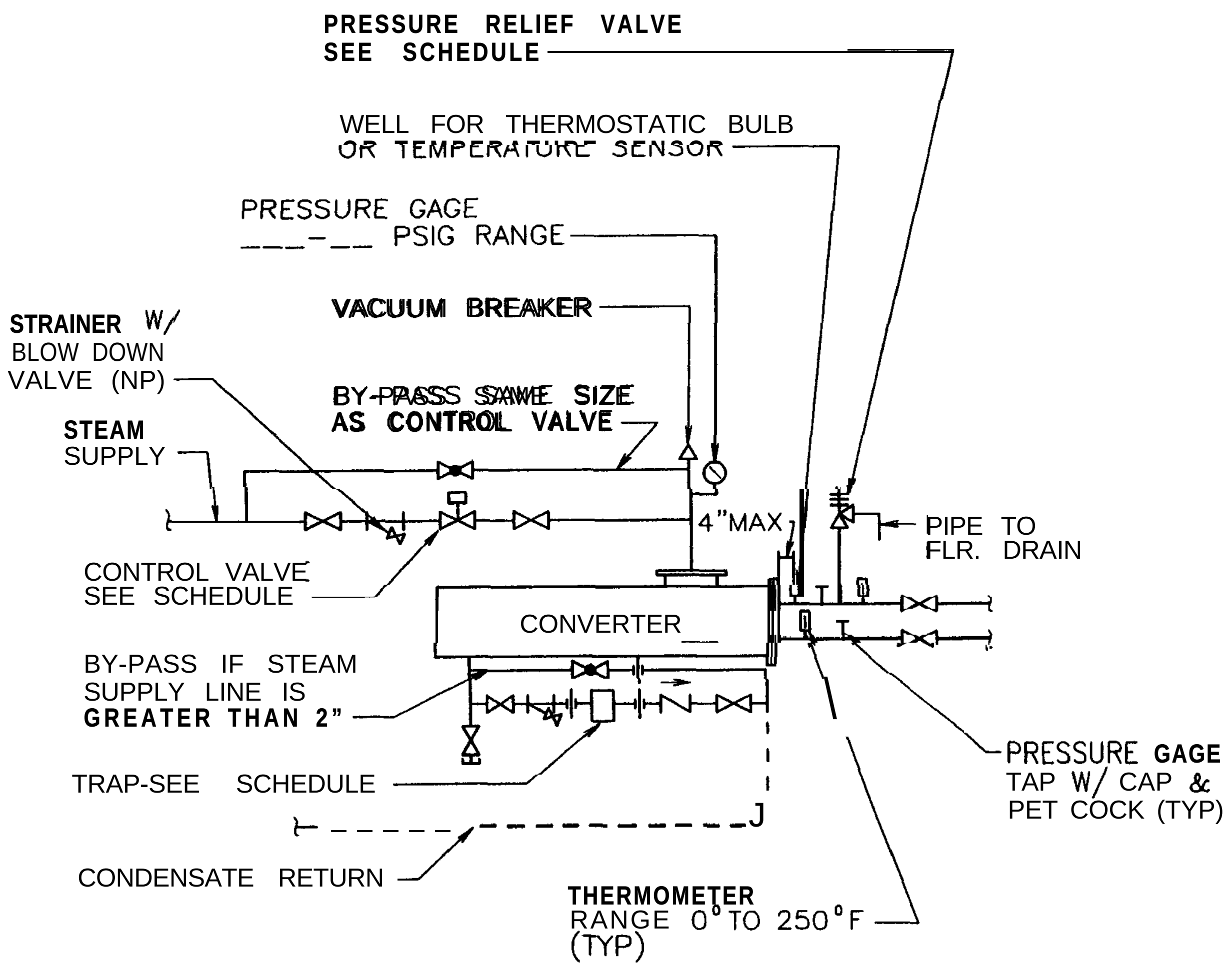


* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP/DOWNSTREAM OF FLOW CONTROL BALANCING VALVE PER MFGR'S **INSTALLATION INSTRUCTIONS**

BASE MOUNTED CENTRIFUGAL PUMP

NO SCALE

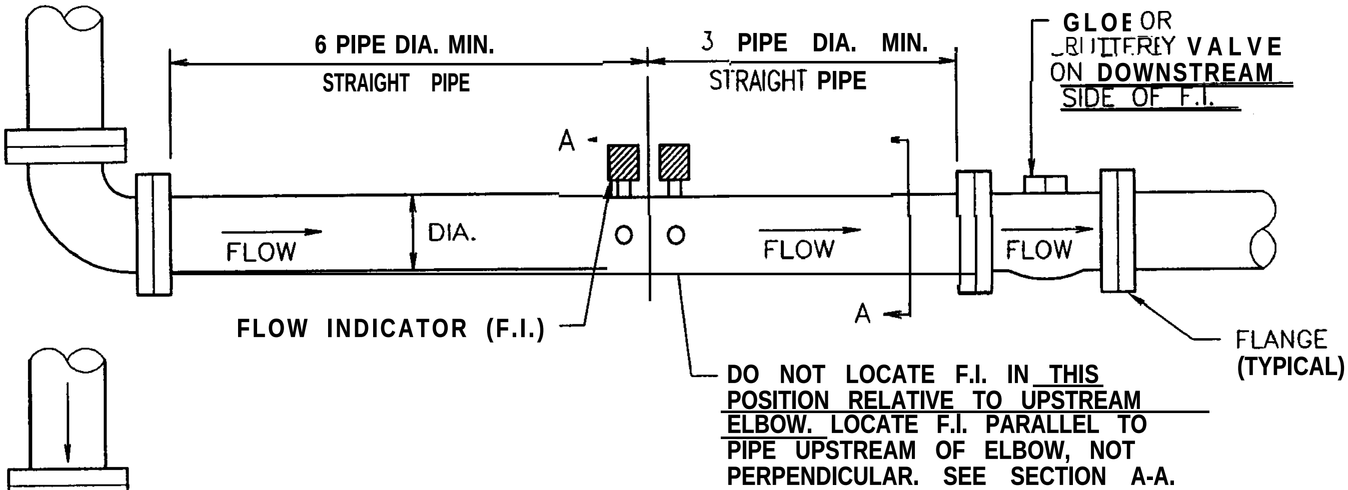
Detail #13

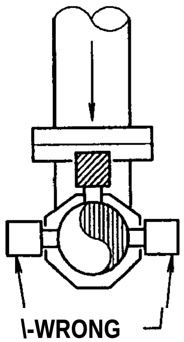


CONVERTER PIPING DETAIL

NO SCALE

Detail #14





SECTION A-A

SHOWING RELATIONSHIP OF FLOW INDICATOR TO UPSTREAM ELBOW

NOTES:

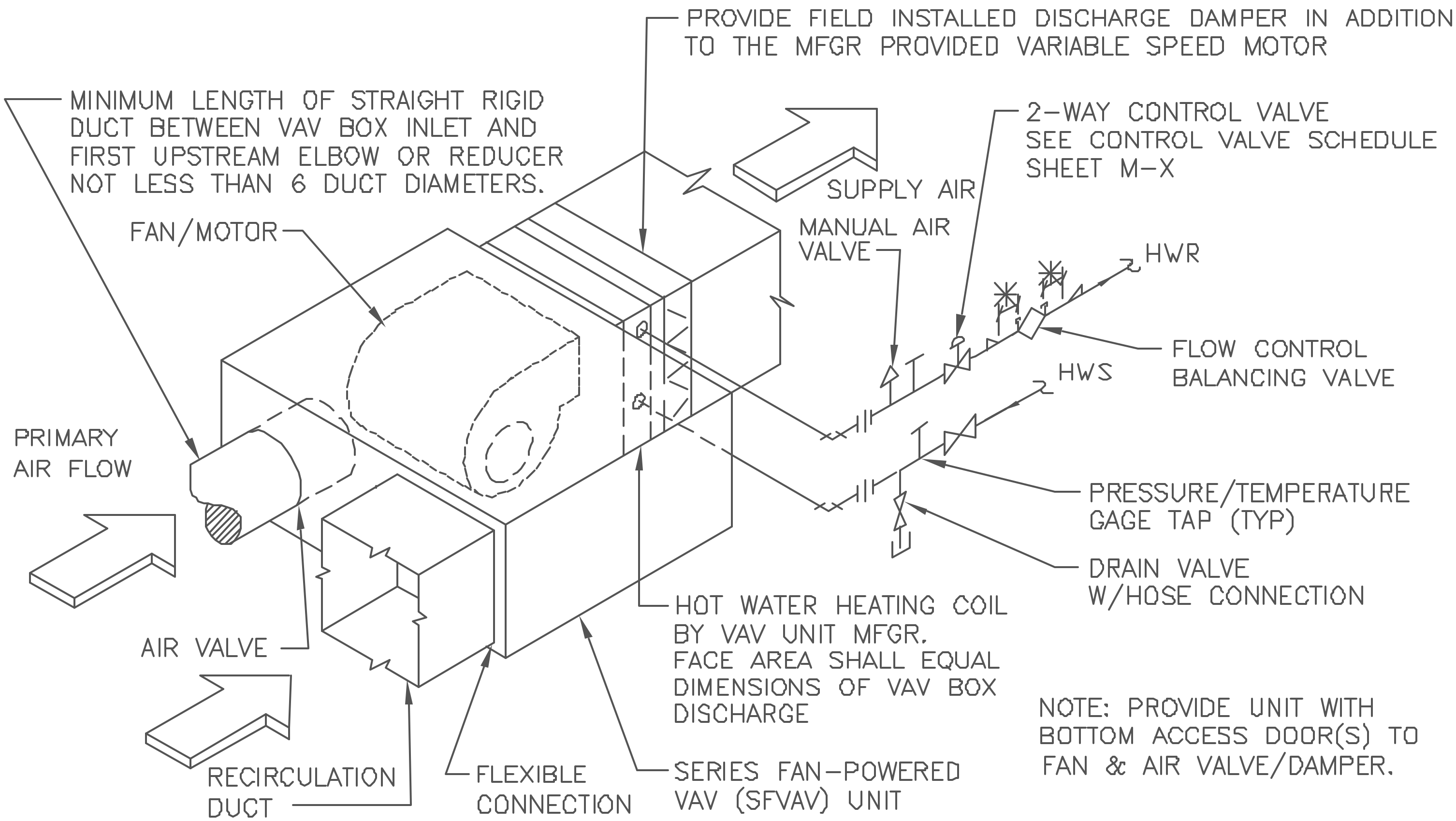
1. ONLY STRAIGHT PIPE IS TO BE WITHIN MINIMUM UPSTREAM & DOWNSTREAM DIMENSIONS, NO FITTINGS OR VALVES ARE ALLOWED.

2. F.I. & VALVES SHALL BE ORIENTED FOR EASY ACCESS. IF TOP OF PIPE IS CLOSE TO STRUCTURE OR OBSTRUCTIONS, ARRANGE PIPING TO LOCATE VALVE OPERATOR & F.I. CONNECTIONS ON SIDE OF PIPE. NO VALVEI SHALL BE INSTALLED WITH THE OPERATOR BELOW THE HORIZONTAL.

FLOW INDICATOR (F.I.) DETAIL

NO SCALE (FOR PIPES 10" AND LARGER)

Detail #15

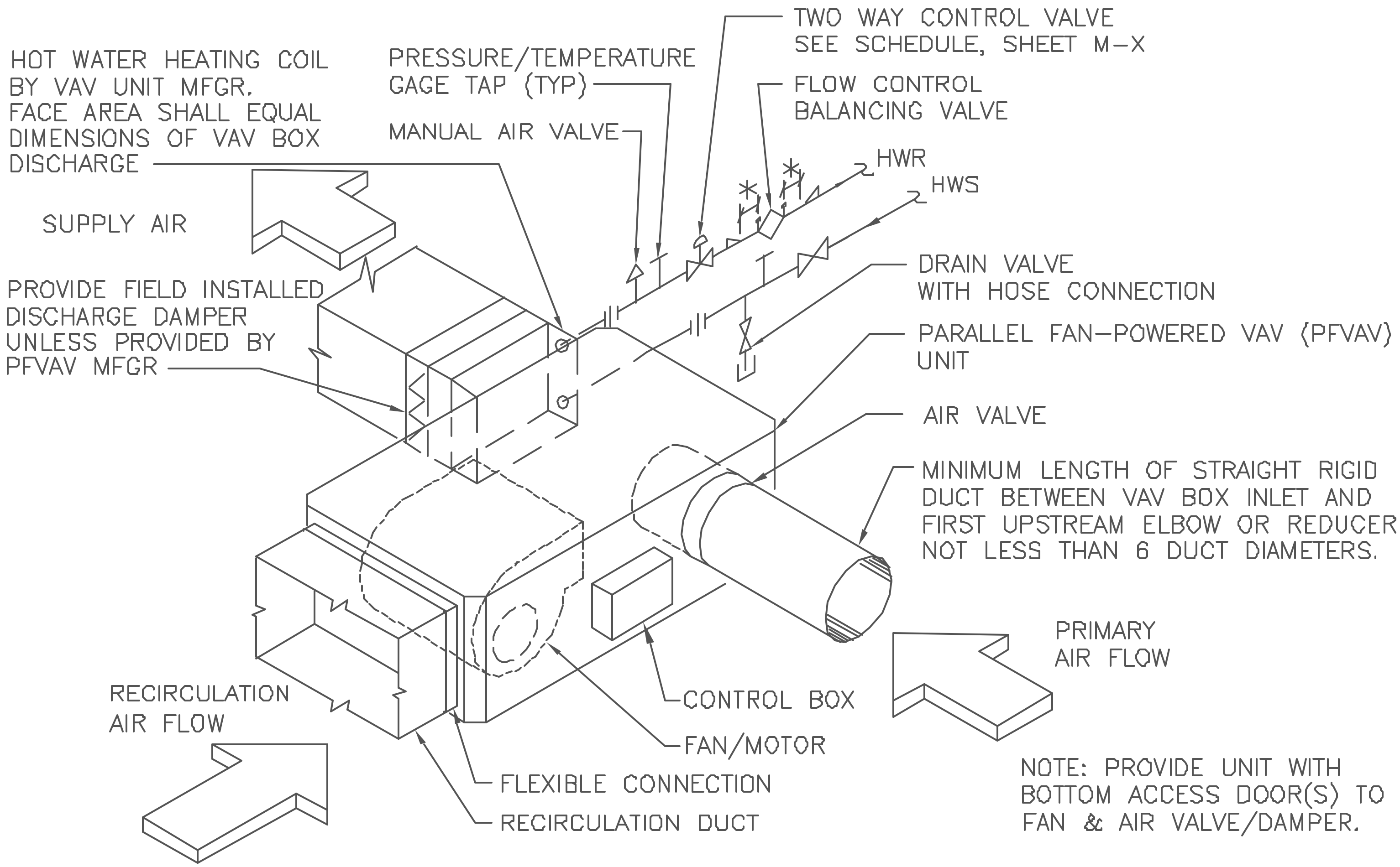


* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP/DOWNSTREAM OF FLOW CONTROL BALANCING VALVE PER MFGR'S INSTALLATION INSTRUCTIONS

SERIES FAN-POWERED VAV (SFVAV) UNIT DETAIL

NO SCALE

Detail #16

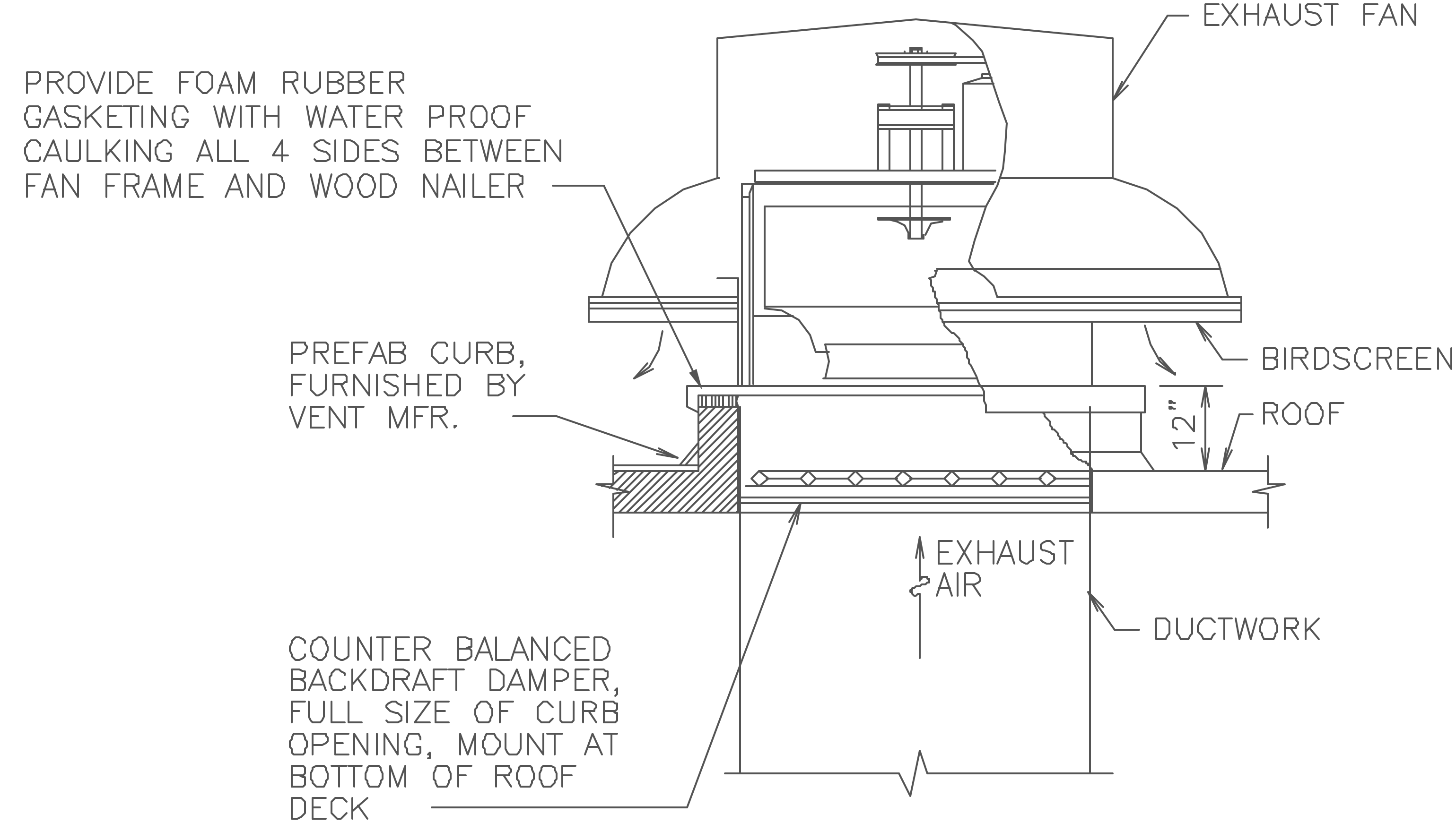


* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP/DOWNSTREAM OF FLOW CONTROL BALANCING VALVE PER MFGR'S INSTALLATION INSTRUCTIONS

PARALLEL FAN-POWERED VAV (PFVAV) UNIT DETAIL

NO SCALE

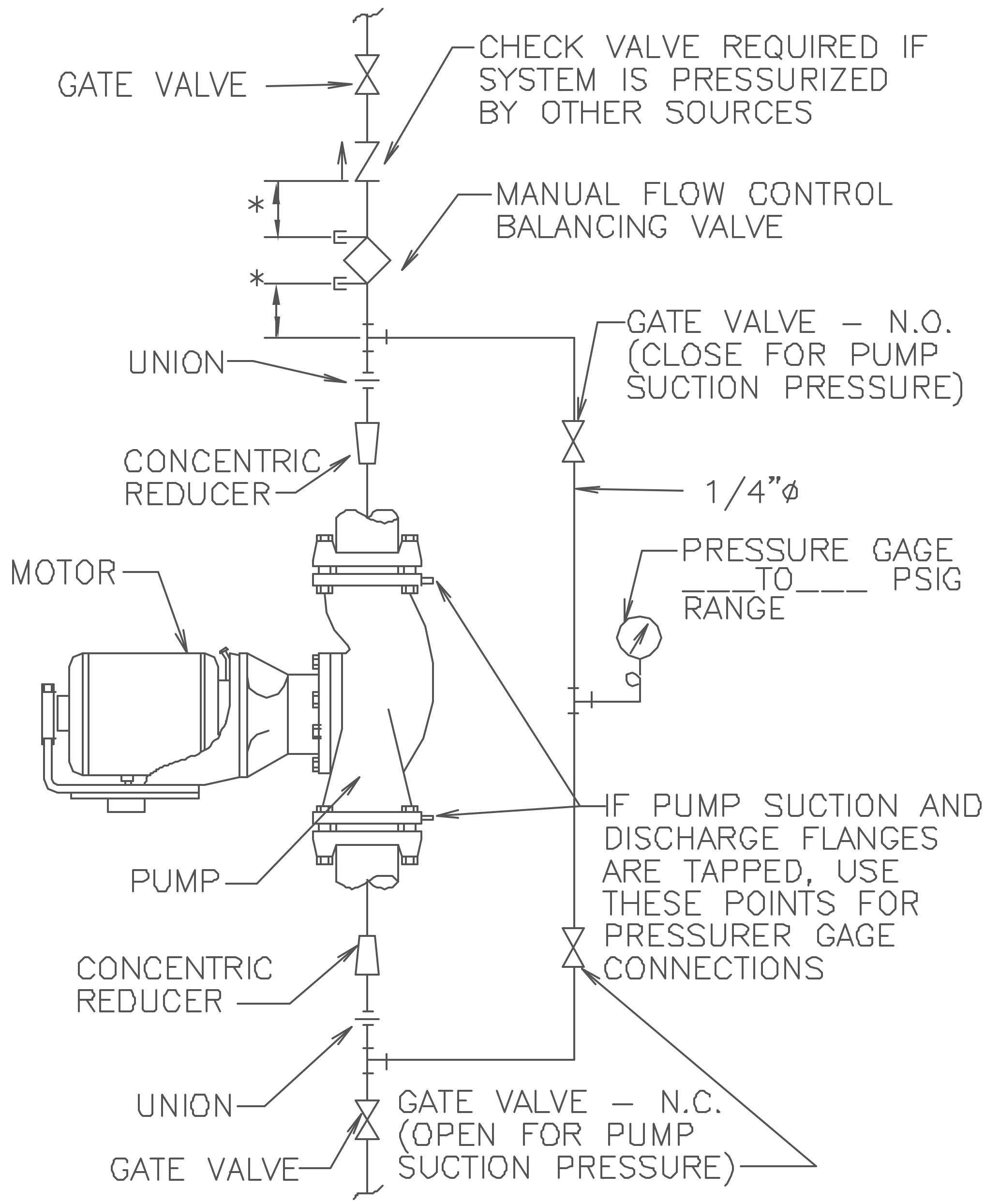
Detail #17



EXHAUST FAN DETAIL

NO SCALE

Detail #18



* STRAIGHT LENGTHS OF UNOBSTRUCTED PIPE WITHOUT INLINE APPURTENANCES SHALL BE INSTALLED UP/DOWNSTREAM OF FLOW CONTROL BALANCING VALVE PER MFR'S INSTALLATION INSTRUCTIONS

INLINE CENTRIFUGAL PUMP

NO SCALE

Detail #19

FILENAME: FINALDALTS.DWG, UPDATED ON 12/20/01 AT 14:29, XREFS: NONE

ASHRAE 90.1 RECOMMENDED MINIMUM DUCT SEAL CLASS

DUCT LOCATION	DUCT TYPE: SUPPLY ≤2 IN WC	DUCT TYPE: SUPPLY >2 IN WC	DUCT TYPE: EXHAUST	DUCT TYPE: RETURN
OUTDOORS	A	A	C	A
UNCONDITIONED SPACES	B	A	C	B
CONDITIONED SPACES	C	B	B	C

INCLUDES INDIRECT CONDITIONED SPACES SUCH AS RETURN AIR PLENUMS

TEST PRESSURE SHALL EQUAL TO DUCT PRESSURE CLASS RATING IN INCHES WATER COLUMN. NOTE: ONLY USE POSITIVE PRESSURE FOR TEST PRESSURE SINCE DUCTWORK IS NOT TESTED UNDER NEGATIVE PRESSURE.

IF USING ROUND OR OVAL DUCT REMEMBER TO SPEC THE RECTANGULAR DUCT OUT OF THE FAN.

CAN BE POSITIVE OR NEGATIVE

DUCT CONSTRUCTION AND LEAK TEST SCHEDULE

MARK	DUCT PRESSURE CLASS INCHES WATER COLUMN				SUPPLY				RETURN/ OUTSIDE AIR		DUCT TEST PRESSURE INCHES WATER COLUMN	REMARKS
					ROUND/OVAL		RECTANGLE					
	SUPPLY DUCT	RETURN DUCT	EXHAUST DUCT	OUTSIDE AIR DUCT	DUCT SEAL CLASS	DUCT LEAK CLASS	DUCT SEAL CLASS	DUCT LEAK CLASS	DUCT SEAL CLASS	DUCT LEAK CLASS		
PACKAGED ROOFTOP UNIT–VAV	4	–	–	–	A	3	A	6	–	–	4.0	1
	–	–2	–	–	–	–	–	–	C	24	2.0	1
PACKAGED ROOFTOP UNIT–CONST VOLUME	2	–	–	–	–	–	C	24	–	–	2.0	1
	–	–1	–	–	–	–	–	–	C	24	1.0	1
AIR HANDLING UNIT WITH ECONOMIZER–CONSTANT VOLUME	2	–	–	–	C	12	C	24	–	–	2.0	1
	–	–1	–	–	–	–	–	–	C	24	1.0	1
	–	–	–.5	–	–	–	C	24	–	–	.5	1
	–	–	–	–1	–	–	–	–	C	24	1.0	1
SERIES VAV UNITS	2	–	–	–	–	–	C	24	–	–	2.0	1
	–	–.5	–	–	–	–	–	–	C	24	.5	1 2
EXHAUST DUCT	–	–	–1	–	–	–	C	24	–	–	1.0	1
EXHAUST DUCT	–	–	–1	–	–	–	C	24	–	–	1.0	2

1 TEST IN ACCORDANCE WITH SPEC SECTION 15950, HVAC TESTING/ADJUSTING/BALANCING AND THE PROCEDURES IN SMACNA HVAC AIR DUCT LEAKAGE TEST MANUAL, 1985 EDITION.

2 NO TEST REQUIRED

NOT ALL DUCT REQUIRE TESTING. USE JUDGMENT

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

LANTDIV SKETCH NO. — DATE: 12–20–01

THIS SKETCH REVISES IN PART NAVFAC DWG. NO.

DUCT CONSTRUCTION AND LEAK TEST SCHEDULE

DESIGN: JTI
DRAWN: ___
REVIEW: ___

SPEC. NO.

SAMPLE

CONSTR. CONTR. NO.

DESIGNED & ENGINEERED BY: LANTDIV NAVAL FACILITIES ENGINEERING COMMAND

REVISION 12 DEC 2000

TAB K

PROGRESS PAYMENTS

Final Letter

DOC: TABS.DOC
Ser
10 JUL 97

From: Commander, Naval Facilities Engineering Command
To: Distribution

Subj: **TEST, ADJUST AND BALANCE (TAB) SCHEDULE/MILESTONES**

Encl: (1) TAB Schedules/Milestones Guidance

1. This letter establishes a requirement for contractors to provide a detailed listing of TAB field work for Heating, Ventilating and Air Conditioning (HVAC) systems. The implementation guidance is provided by enclosure (1) and is applicable to all newly awarded contracts. Enclosure (1) requires TAB field work to be broken down in the Schedule of Prices or the Network Analysis System by separate line items which reflect measurable deliverables. The enclosure provides recommended guidance for breaking down TAB field work with the specific payment percentages for each line item to be determined on a case by case basis. The recommended stages for breaking down TAB field work have been selected with a view towards facilitating regular progress payments for TAB contractors and improving the quality of HVAC work by making it easier to monitor the work in stages.

2. The quality of HVAC work has been an issue within DoD over the years. The requirements provided by enclosure (1) will encourage persons responsible for TAB work to become more familiar with what is required and should result in improved quality of HVAC systems. NAVFAC P-68 and applicable NAVFAC guide specifications will be revised to include this change. The point of contract on this matter is Vincent Spaulding, 703-325-7655 or Miguel López, 703-325-9015.

ROBERT R. BOYER
By direction

Distribution:
COMPACNAVFACENGCOM (00, 02)
COMLANTNAVFACENGCOM (00, 02)
CO SOUTHWESTNAVFACENGCOM (00, 02)
CO SOUTHNAVFACENGCOM (00, 02)

Subj: **TEST, ADJUST AND BALANCE (TAB) SCHEDULE/MILESTONES**

CO NORTHNAVFACENGCOM (00, 02)
CO EFA CHESAPEAKE (00, 02)
CO EFA NW (00, 02)
CO EFA MIDWEST (00, 02)
CO EFA MED (00, 02)
CO EFA WEST (00, 02)
CO PWC JACKSONVILLE (00,200)
CO PWC PEARL HARBOR (00,200)
CO PWC GUAM (00,200)
CO PWC GREAT LAKES (00,200)
CO PWC NORFOLK (00, 02)
CO PWC PENSACOLA (00,200)
CO PWC SAN DIEGO (00,200)
co PWC SAN FRANCISCO (00,200)
co PWC YOKOSUKA (00,200)
CO PWC WASHINGTON (00,200)
PMRTEAM
CO, CML ENGINEER CORPS OFFICERS SCHOOL
NAVAL FACILITIES CONTRACTS TRAINING CENTER
NAVAL FACILITIES CONTRACT OFFICE, PORT HUENEME (27)

TEST, ADJUST AND BALANCE **(TAB) SCHEDULE/MILESTONES GUIDANCE**

A. The TAB field work shall be broken down in the Schedule of Prices or the Network Analysis System by separate line items which reflect measurable deliverables. Specific payment percentages for each line item should be determined on a case by case basis for each contract.

B. The contractors shall be required to break down TAB work using the following line items for TAB progress payment schedule/milestones applied, as appropriate, on a project by project basis:

1. **Approval of design** review report: The TABS Agency is required to conduct a review of the project plans and specifications to identify any feature, or the lack thereof, that would preclude successful testing and balancing of the project HVAC systems. The findings resulting should be submitted to the Government to allow correction of the design. The progress payment should be issued after review and approval of the report.

2. **Approval of the pre-field engineering report:** The TABS Agency submits a report which outlines the scope of field work. The report should contain details of what systems will be tested, procedures to be used, sample report forms for reporting test results and a quality control checklist of work items that must be completed before TABS field work commences.

3. Season I **field work:** Incremental payments are issued as the TABS field work progresses. The TABS Agency mobilizes to the project site and executes the field work as outlined in the pre-field engineering report. The HVAC water and air systems are balanced and operational data should be collected for one seasonal condition (either summer or winter depending on project timing.).

4. **Approval of Season I** report: On completion of the Season I field work, the data is compiled into a report and submitted to the Government. The report is reviewed, and approved, after ensuring compliance with the pre-field engineering report scope of work.

5. **Completion of Season** I **field QA check:** Contractor QC and Government representatives meet the TABS Agency at the jobsite to retest portions of the systems reported in the Season I report. The purpose of these tests are to validate the accuracy and completeness of the previously submitted Season I report.

6. **Approval of Season II report:** The TABS Agency completes all season II field work, which is normally comprised mainly of taking heat transfer temperature readings, in the season opposite of that under which season I performance data was compiled. This data should be compiled into a report and submitted to the Government. On completion of submittal review to ensure compliance with the pre-field

engineering report scope, progress payment is issued. Progress payment is less than that issued for the Season I report since most of the water and air balancing work effort is completed under Season I.

TAB L

SUBMITTAL PROCEDURES

TABS/ACATS/DALTS SUBMITTAL REVIEW PROCEDURES

To ensure that consistent procedures are followed in the processing and review of TABS, ACATS and DALTS submittals, the following guidelines are provided. We have presented the material below so that it is keyed to each activity as numbered on the enclosed flow diagram. We encourage the ROICC to use this procedure, as it has been found to provide prompt review of the submittals and avoids much confusion and frustration for the Contractors as compared to previous submittal review procedures.

Item 1 – The Contractor will forward all submittals pertaining to TABS, ACATS and DALTS to NAVFAC ATLANTIC/PACIFIC to Code CI52:

a. Specification Sections 15901 & 15910 list Field Test Plan, Performance Verification Test Plan, and Certification Test Report. We wish to emphasize that NAVFAC ATLANTIC/PACIFIC CI52 does not review technical and catalog automatic controls submittals. Those particular submittals should be submitted to NAVFAC ATLANTIC/PACIFIC CI43 or the A-E, as applicable.

- Field Test Plan
- Performance Verification Test Plan
- Certification Test Report

b. Specification Section 15950, Testing/Adjusting/Balancing: Heating/Ventilating/Cooling Systems:

- Agency/personnel Qualifications
- Design Review Report
- Pre-field Engineering Report
- Prerequisite Checklist and Notice of Work
- DALTS Final Certified Report
- Season I TABS Report
- Season II TABS Report

Item 2 – All submittals are logged in by NAVFAC ATLANTIC/PACIFIC CI4A1 when received from the Contractor. A routing memorandum is attached to the submittal, which is then forwarded to CI52.

Item 3 – The submittal is logged into a submittal control log by CI4A1 and screened by CI4A1 to determine whether it will be reviewed by CI52 or CI43.

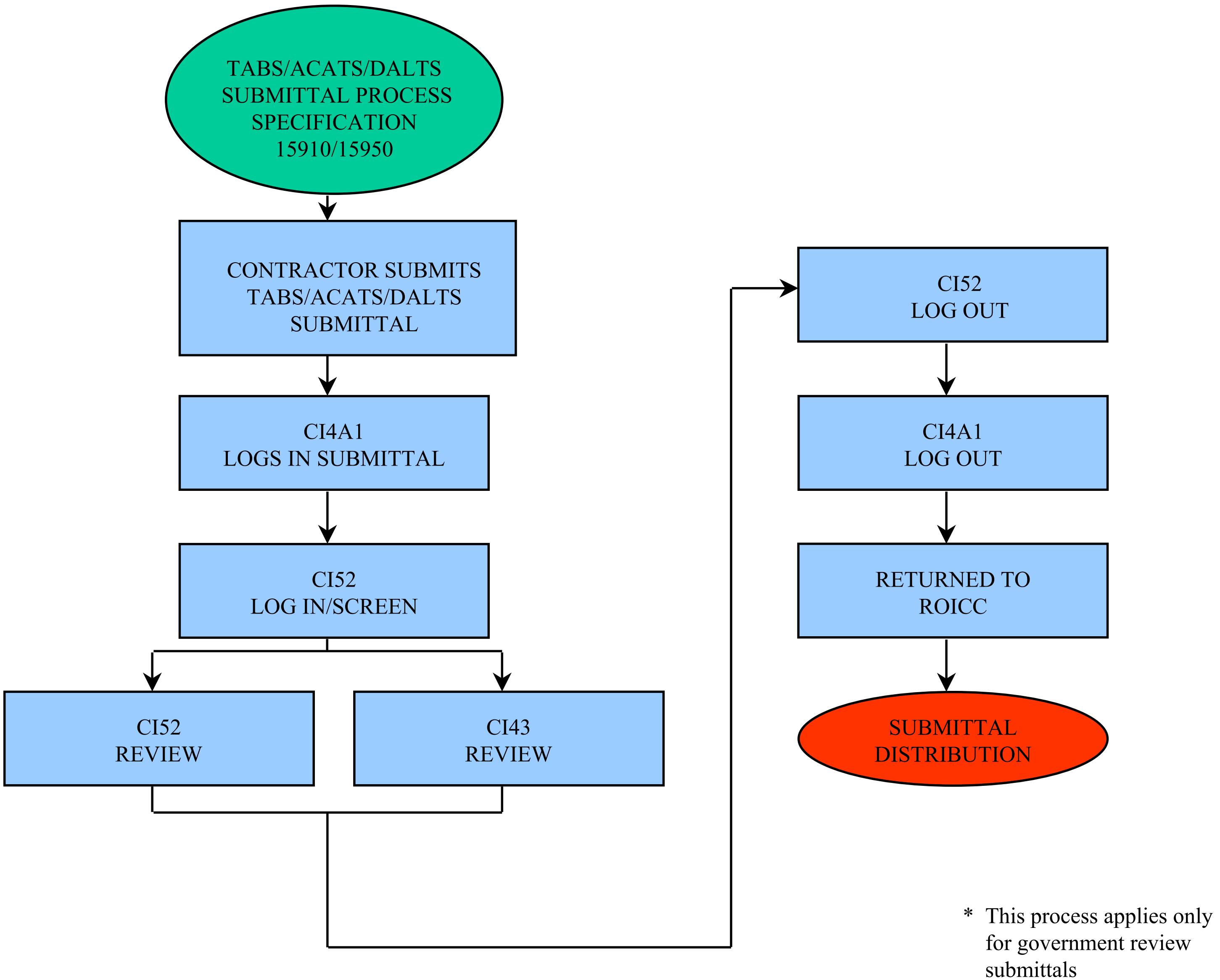
Item 4 – Submittals that are to be reviewed by CI43 or CI52 are hand carried to respective code.

Item 5 – The submittal is reviewed by CI43 or CI52. Upon completion of review, the submittal is stamped by the reviewer.

Item 6 – Submittals reviewed by either CI52 or CI43 are logged out with CI52 and CI43 upon completion of review. On receipt of the submittal package, CI4A1 logs the submittal for return to the ROICC. One copy of the submittal is retained by CI52 or CI43 and filed.

Item 7 – On receipt of the submittal from CI4A1, the ROICC will return the submittal to the Contractor.

Item 8 – All submittal copies are distributed by the ROICC.



TABS/ACATS SUBMITTAL ROUTING PROCESS

TAB M

GUIDANCE TO CONTRACTORS

PROVIDING GUIDANCE/ADVICE TO THE CONTRACTOR ON TABS/ACTS

It has been our experience that most Contractors want to do a good job. The better informed the Contractor is on all facets of the contract the more likely he is to perform well. The earlier in the contract that information process starts the more effective the results are likely to be. This applies doubly where TABS and ACTS are concerned. An early exchanged of information on the process increases the likelihood of a successful TABS/ACTS completion.

We have enclosed a copy of an information package that was prepared by ROICC Jacksonville NC. They routinely provide this information to the Contractor as a mean of developing an awareness of the contract requirements for TABS. The package is provided to the Contractor early after award on all contracts that contain TABS. We consider this to be an excellent tool for getting a Contractor started in the right direction. It conveys a message that the Government is very serious about having the work thoroughly implemented and provides advice on how to avoid problems. A listing of problem areas is provided which forewarns the Contractor of possible pitfalls. We highly recommend and encourage all ROICC offices to make use of a similar information package in administering their contracts.

DEPARTMENT OF THE NAVY
OFFICER IN CHARGE OF CONSTRUCTION
RESIDENT OFFICER IN CHARGE OF CONSTRUCTION
NAVAL FACILITIES ENGINEERING COMMAND CONTRACTS
CAMP LEJEUNE, NORTH CAROLINA 28542-5000

RECEIVED 21 JUN

IN REPLY REFER TO:
(919) 451-2581
N62470-88-C-8110
JAX/10C/grh
19 June 1991

J. W. Cook and Sons, Incorporated
Post Office Box 39
Highway 701 North
Whiteville, North Carolina 23472

RE: CONTRACT N62470-88-C-8 110, FIELD MAINTENANCE COMPLEX (INCREMENT III), MARINE CORPS BASE, CAMP LEJEUNE, NORTH CAROLINA

Gentlemen:

In recent years the Navy has placed great emphasis on the TABS program by specifying more detailed technical and administrative TABS requirements and by aggressively enforcing these requirements. Unfortunately, many contractors were initially unprepared for this increased emphasis resulting in liquidated damages being assessed, disputes arising and a general feeling that the government was being overzealous and insensitive to the contractor's plight.

This letter is intended to stress our commitment toward ensuring a successful TABS program on this contract and to hopefully avoid some of the previous pitfalls we have encountered with TABS. The enclosed brochure, "The TABS Solution", is provided to explain the whys and wherefores of TABS and offers some pointers to assist you in preparing your plan of attack in executing your TABS program. Also, I am enclosing a handout, "TABS TIPS", which provides some "lessons learned" type information provided by the TABS industry which you may find beneficial. Taking a few minutes to read the enclosed materials could save you both time and money.

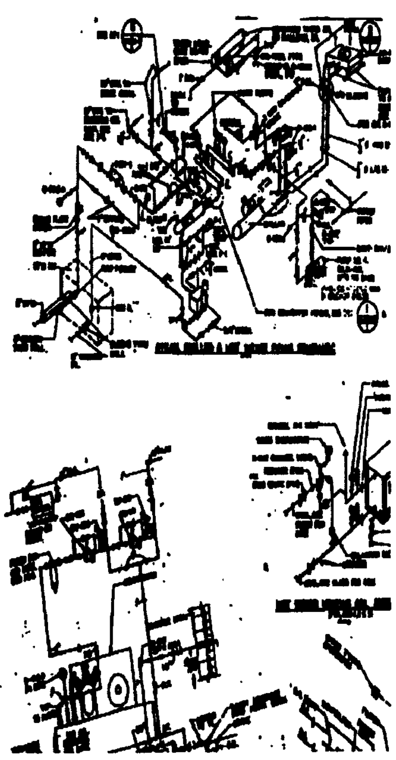
The AROICC assigned to your project, Mr. Mike Lynch, will devote his full attention to TABS during the day-to-day administration of the TABS process. Also, Mr. J. C. Wade of our staff is one of the most knowledgeable individuals at Camp Lejeune in the TABS program. Please don't hesitate to to give Mr. Wade a call at (919) 451-5006 if you need assistance. With your active participation, I look forward to a successful completion of the TABS requirements of your referenced contract.

Sincerely,

Gary R. Horne

Gary R. Horne, P.E.
Deputy Resident Officer in
Charge of Construction

the TABS Solution



Introduction

Imagine yourself developing a prime piece of property by constructing a moderately priced three story office building for lease. The price of the facility is about $3,000,000 with four clients already committed to lease space. The largest leasee is a database management company who leases the entire 1st floor for their computer support center. The remaining two floors are leased by accountants and doctors.

Now imagine the tenants take possession in early June, and by late July, your nightmare begins. First, the database company threatens to file suit to recover for damages caused by massive computer failures due to excessively high heat and humidity. Then, the accountants and doctors inform you that they are looking elsewhere for office space because of employee and customer complaints due to high heat and lack of ventilation. You go back to the contractor, who blames the architects, who blame the engineers, who blame the contractor.

Unfortunately, the government's been there, and thus the TABS program was born.

Testing, Adjusting, Balancing, and Start-up

TABS is a methodical, structured and formalized procedure for ensuring the government is provided WAC systems that perform within their design parameters and are reliable. Anyone building a facility, even a home buyer, expects nothing less. You, the contractor, are concerned about quality construction and TABS should be viewed as a tool to assist you in providing only the highest quality product. To that end, we've prepared this brocure not only to emphasize our commitment towards making the TABS process work but also to assist you in complying with one of the most important requirements of your contract. The following tips concern areas which appear to cause the majority of the problems encountered with the TABS program:

a) *Read your TABS specification very **carefully!** It is important that you thoroughly understand what the contract requires. As the process evolves, the TABS specification sections may vary from contract to contract so don't assume this contract has the same requirements as a previous contract that you may have been involved with.*

b) ***Know** the TABS firm that you are dealing **with!** We ask for documentation of their experience, but you should* ensureyourself that they not only have the technical expertise to accomplish the task but should also be stable and motivated enough to do the job quickly and effectively. Some of the biggest headaches that we've had were with TABS firms who either didn't fully understand what was required or didn't have sufficient money in their quote to satisfactorily complete the job, or both.

c) Be very sensitive to the time constraints governing the TABS process. Contractors who have problems with T'S are invariably untimely in meeting their submittal timetables. Build these timetables ***into your project scheduling system and flag these*** items as critical.

d) Be aware that your TABS engineer must review the plan8 and bring any design deficiencies or omissions to the government'8 attention. Many contractors are under the mistaken impression that design omissions and deficiencies which surface during the testing and balancing stage are entirely the ***government's*** responsibility. Wrong!' Your ***TABS*** engineer is specifically tasked with submitting a design review report listing any omissions or deficiencies which may preclude the TABS team from complying with the contract requirements. In the unlikely event the TABS engineer discovers no deficiencies, he must so state in writing.

e) The "Pre-TABS" meeting could be one of the ***most important meetings ofthe contract.*** We have a TABS representutive on our staff who will be closely involved with the TABS program. The initial meeting is intended to discuss submittals, work schedules and field quality control. You should plan to have appropriate personnel at the meeting and be prepared to discuss any aspect of your TABS program.

f) Think of execution of the TABS program a8 a team effort! You should not ***feel*** alone when pursuing TABS. The ROICC office, the designers, ***LANTNAVFACENGCOM and the contractor are key players in the process and must all work together for a successful completion. Our staff stands ready to assist you anyway they can with*** your questions or-problems regarding ***TABS***. The TABS program has been put on the front burner by the Naval Facilities Engineering Command, and we urge that you do the sume. Many contractors watch with dismay as their projects are accepted with ***liquidated*** damages because TABS was ***notgiven the*** attention or priority it deserved. ***Your*** top ***man***agetnent, the CQC representative, the project manager and the superintendent should be attuned to the importance of the TABS process and their

roles ***in*** accomplishing the ***taskat*** hand. By working together, we can and will make it work!

g) Remember, theproject cannot be accepted until all TABS requirements are satisfied. As stated earlier, some contractors have watched their profit margin shrink because the project could not be accepted due to TABS problems. Although specifically stated in thecontract, contractors often feel that this requirement is extreme, with thegovernment being ***overzealous*** in its enforcement. But rernernber back to the imaginary scenario in the introduction, and you should understand why it's critically important that we accept a completed product free of construction ***and/or*** design ***related me***chanicalproblerns. Previous mechanical disasters with newly constructed facilities have prompted the Navy's TABS program, and we hope that you will choose to be part of the TABS solution rather than part of the problem.

h) DON'T BE AFRAID TO ASK QUESTIONS!

TABS TIPS

)

A Virginia based TABS firm, Tidewater Services of Cheasapeake,Inc., recently prepared a presentation at the request of Atlantic Division,' Naval Facilities Engineering Command to convey to Government personnel the industry's views of the TABS process now being implemented on large construction contracts. We felt it may be beneficial to condense this presentation and share it with you prior to construction start to assist you in establishing your TABS strategy. For simplicity sake, we've presented most information in outline form with little commentary. The areas we'd like to emphasize include pre-planning, expediency in the submittal process, quality of ductwork installation and provision of adequate test ports. We'd also like to remind you that we cannot accept a facility until all TABS requirements have been satisfied.

Key Elements for Sucessful TABS

- **Communications**
- **Coordination of Subcontractors (by Prime)**
- **Cooperation Between Subcontractors**
- **Early Involvement of ROICC**
- **Prerequisite Checklist(Properly Executed)**
- **Good Specification**

Your TABS Program Can:

- Improve comfort level for occupants.
- Cause less trouble calls after occupancy.
- Reduce maintenance costs.
- Reduce operating costs.
- Improve designs on future projects.

Positive Changes Resulting From TABS:

- Evolvement to better quality duct systems.
- Improved piping systems.
- Increased knowledge of CQC and Project superintendents.
- A/E Firms are becoming more aware of TABS in their designs (even in private work).

TABS Submittals

- Qualifications:
  Fairly straight forward.

- Design Review Report:
  Questions brought out deserve a reply. This review is intended to allow the TAB Engineer to identify any problems that may prevent proper balance of the systems.

- TAB Agenda=
  Used to communicate the TAB Engineer's intentions of what equipment/systems will be tested and how he intends to go about this work This is his 'plan of attack'!

- Work Strategy & Schedule:
  Difficult to determine the actual schedule early in t&project.

TABS Submittals
(continued)

- **Pre-field Data:**
  Submit actual test forms to be used with any field data filled in that can be generated from the the plans and equipment submittals.
- **TAB Test Ports:**
  Coordination required between Sheet Metal Contractor and TAB Agency.
- **Prerequisite Checklist**
  The most important item! This is a tool to be used in the coordination of the TABS field process. This item is mentioned on the average of five times in most specs.

Prerequisite Checklist
(Single Most Important Item for Success)

- **Statement of completion:**
  Prime contractor states that the HVAC system is installed per plans and specs, and is complete.
- **All systems commissioned:**
  The systems have been started and debugged and are ready for operation. By submitting this checklist, the contractor is stating that he is satisfied that his firm, as well as his subs, have successfully and completely finished with these systems.
- **Authorizing system operation:**
  In addition to the above items, the contractor is authorizing the TAB Agency to operate all systems (start/stop/adjust) as required to balance.

Prerequisite Checklist
(continued)

- **Authorizing field testing of equipment:**
  The contractor is also stating that he is prepared for his equipment to be tested as installed, and the results of these tests complied as the TAB Report.
- **A major point of contention:**
  The completion and submission of the prerequisite checklist is merely notification for the TAB Agency to begin establishing the mechanical punchlist. THIS IS NOT THE CASE!
- **Payment note:**
  The Mechanical, Sheet Metal and ATC contractors should not be "over paid" on progress billings, prior to the submission of t this checklist.

Common Field Problems

- Leaks in ductwork.
- Duct systems not installed per plans and specs.
- Insufficient net free area on O.A. intakes/outlets.
- Dirty water systems
- Air in water systems.
- Grill/diffuser connections to ductwork leaking. Very noticeable with lay-in ceiling.
- Excessive lengths of flex duct; flex not properly supported
- Exhaust fan connection at roof curb.
- Equipment installed in wrong location.
- Undocumented field changes to air and water systems.

And Finally:

The TABS Agency stressed early ROICC involvement in the TABS process. They see the ROICC as the catalyst in making things happen, such as ensuring an early award of *the TABS subcontract* by *insisting* on *timely submissions of* the Qualifications submittal, the Design Review, and the Prerequisite Checklist. Timely submissions can avoid the cost ripple caused by duct rework or provisions of additional test ports. Timely submissions can also help avoid the pain of liquidated damages.

TAB N

REFERENCE PUBLICATIONS

REFERENCE PUBLICATIONS

The following provides a listing of recommended TABS reference publications, which should be available at all, ROICC offices:

a Testing. Balancing and Adjusting of Environmental Systems, William G. Eads, P. E., Publisher: Sheet Metal and Air Conditioning Contractors' National Association, Inc.

b HVAC Air Duct Leakage Test Manual, 1st Edition, 1985, Publisher: Sheet Metal and Air Conditioning Contractors' National Association, Inc.

c ASHEAE Handbook and Product Directory. 1980 Systems, Publisher: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

d Associated Air Balance Council National Standards, Fifth Edition, 1989, Publisher: Associated Air Balance Council

e Procedural Standards for Testing. Adjusting. Balancing of Environmental Systems, Fifth Edition, 1991, Publisher: National Environmental Balancing Bureau